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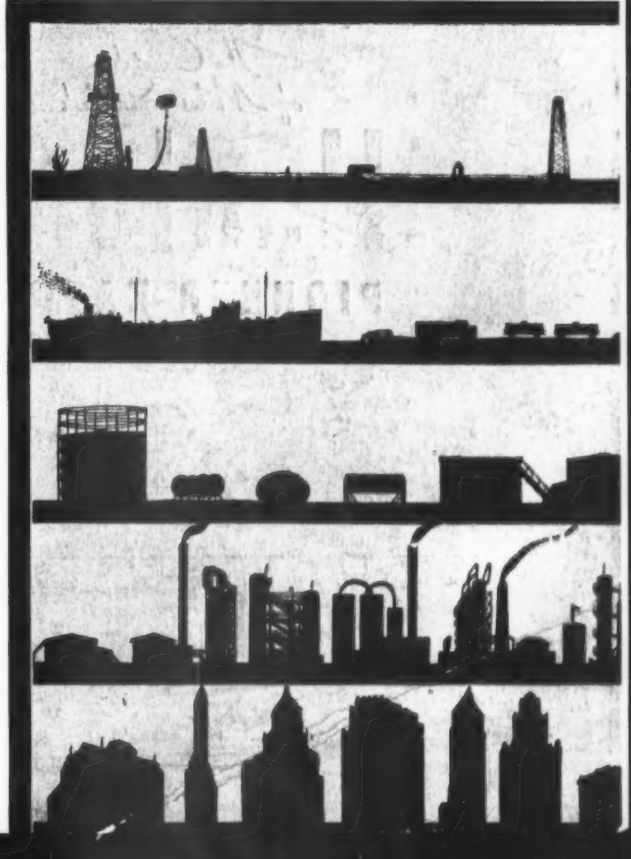

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"We'll Get There Somehow" is the title of the impressive picture shown above—reproduced from one of the outstanding oil-industry advertisements of the past year. No other pictorial has so vividly portrayed the constant struggle involved in carrying out oil-field operations.—Reproduced through courtesy of Halliburton Oil Well Cementing Co.

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PETROLEUM

Destructive Proposal

To rid the barn of rats burn down the barn. The remedy is effective but the result is achieved at a cost wholly disproportionate to its benefits. The comparison is suggested, however, by contemplation of some of the legislation proposed in Washington, particularly that in regard to holding companies, competition of the government with private business and now in the project which would prohibit a single corporation from engaging in more than one branch of the oil business.

Separation of pipe lines from refining and producing companies has been proposed on previous occasions and the economic fallacy of the proposal has been exposed. The only semblance of effective reason for such action disappeared when the lines were made common carriers. The new agitation for disintegration is based on different grounds. Its principal object is to make possible the enforcement of Rules 4 and 6 of Article V of the Petroleum Code.

These paragraphs prohibit selling below cost and the use of profits from one branch of the business to offset losses on other operations. They have given rise to more complaints than any other part of the code. Like practically all cost provisions in all industrial codes they have proved unenforceable. Except possibly in the eyes of bureaucratic officials there is nothing sacrosanct about these or any other code requirements. The primary object of all business codes is, or was supposed to be, the promotion of fair and orderly competition. Code provisions that cannot be enforced or do not contribute to the main objective should be revised or eliminated.

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To Rescue Code Rules

Renewed attention has been directed to this proposal for separating the oil business into four divisions dealing respectively with production, transportation, refining and marketing, and to force every oil company to confine itself to one of these branches, by the report just submitted to the Oil Administration by the Petroleum Code Survey Committee on Small Enterprise which recommends the setting up of separate corporations for each division of the industry without requiring separation of management. This in itself would not greatly affect the operations of integrated companies but undoubtedly it would pave the way for later demands for a complete separation of their different activities.

The Committee was moved to make its recommendation because of the plight of refining companies which do not control production of their own and who have been badly pinched by the fact that the price of gasoline has been out of line with the price of crude from the time when the Petroleum Code was adopted. The situation of these independent refiners unquestionably demands consideration but the Committee in its recommendation makes the mistake of attempting to deal with effects instead of removing the responsible cause.

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Refiners' Plight

There is no question that the wholesale price of gasoline during the past year and a half in the United States has been too low to permit refining at a profit with crude selling at a dollar a barrel. It may be argued that crude prices have been too high or gasoline prices too low, but in either case the relationship has been out of adjustment. What is the reason? Fundamentally it is the failure to control production. Had the output of crude been held to the figures set by the Oil Administrator, permitting reduction of excessive crude stocks, the price of gasoline would have responded with a reasonable advance long before this time. As the Committee shows in its report actual production from September 1933 to the end of 1934 exceeded these allocations by 61,802,000 barrels. The constant seepage of hot oil during this period, together with the uncertainty as to the legal status of control measures and administrative orders, has been sufficient to prevent any effective stabilization of gasoline prices.

▼

Efforts at Stabilization

This failure cannot be laid at the door of the integrated companies. Throughout the period of code operation repeated efforts have been made to impart stability to the gasoline market and the leadership in such efforts has been taken by representatives of the large integrated companies. These same companies have purchased millions of gallons of "distress" gasoline only to find that they were providing a ready market for the producers of hot oil. The fact is that such efforts in this or any other field are incapable of altering the operation of the law of supply and demand. The universal failure of such attempts

has led to the virtual or open abandonment of price fixing provisions in most of the codes.

That the oil industry itself has been partly at fault in helping to maintain a fictitious crude oil price level must be admitted. One reason for this has been that dollar crude was the first practical accomplishment under the code and has been regarded as the outward symbol of the establishment of better conditions. To maintain it was considered worth some sacrifice. Beyond that was the continuing hope that the regulation of crude production would be made effective. No company wished to be the first to move in breaking down the one definite achievement of code control but cost to the refining and marketing divisions of the industry must be measured in millions of dollars and this cost has fallen with crushing effect on those companies whose operations are confined to the field of refining. There appears to be renewed hope at this time of an improvement in marketing conditions but nothing can be more clear than that an advance in gasoline is essential if the present crude oil price level is to be maintained.

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Gasoline Price Failure

WHEN the proposal for price regulation under the code was first put forward it was agreed that a reasonable price per barrel for crude oil was 18.5 times the wholesale price per gallon of gasoline. On this basis gasoline should have sold at 5.40 cents per gallon since crude oil has sold at a dollar per barrel. Actually the price has varied from 4.36 to 5.13 cents and has averaged 4.63 over the past seventeen months.

Because integrated companies in some cases have been fortunate enough to have obtained earnings from production which have offset their losses on refining and marketing they are accused of desiring to perpetuate a situation involving continued loss from these operations. Such a charge is ridiculous on the face of it.

The integrated company has come into existence because it is an efficient instrument of business. It has been the means of providing the American public with motor fuel at remarkably low prices and has extended the sales of petroleum products to all parts of the world. To destroy this efficiency in order to save a section of the Petroleum Code is to pull down the house in order to save the least important of its contents. A simpler and easier remedy is to be found in enforcing the fundamental requirement of control by limiting production to actual requirements.

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Recalling the Spider and Fly

REVERSION to the antagonism against foreign owned oil companies which halted the progress of the Mexican oil industry a decade ago appears to be indicated by the order of the Minister of Hacienda requiring the Mexican Eagle Oil Company to deposit in Mexico the sum of approximately £2,000,000 or $10,000,000 in gold as a bond in connection with its appeal from a decision requiring payment of damages for the extraction of oil from property title to which is claimed by a company known as Compania Petrolea Comercial.

Contrary to a generally prevailing impression the primary issue is not one between the Mexican Eagle and the Mexican government. Intervention by the latter is confined to the demand for the deposit of gold in the country. The issue is between two corporations and involves the legal title to a single piece of land which represents only a small part of the Eagle Company's total Mexican holdings. It does not involve the company's status in Mexico or its operations on public lands of the country.

The particular property concerned in the case is known as Lot 113 in the Amatlan district. Oil rights in this piece of land were acquired by the company in 1912 by payment of a certain sum to the locally recognized owner together with an agreement for royalty payments on all oil removed. The company's title was recognized as valid by every government up to 1925. In that year a claim was filed by a person who alleged that he was a descendant of the original owner and rightful heir to the property. In the ten years that have passed since that time the claim to ownership has been passed along to two different corporations. With the former of these the Mexican Eagle entered into an arbitration agreement but before the arbitration was concluded the Compania Petrolea Comercial appeared as a factor in the case and refused to recognize the arbitral agreement as valid. After several defeats in the lower courts the Compania Petrolea Comercial finally obtained a decision in its favor from the Superior Court entitling it to collect from Mexican Eagle the value of the oil removed from Lot 113. An appeal to the Supreme Court was taken by the Eagle Company and in accordance with usual procedure a bond for the amount involved was obtained from the Banca de Mexico by a deposit in the Midland Bank of London. This bond the Minister of Hacienda has refused to recognize insisting that gold to the required amount be deposited in Mexico.

Since ample security has been offered demand for the deposit of gold appears designed to embarrass the oil company or possibly to have behind it a more sinister purpose. The Mexican Eagle has sought by various alternatives such as a deposit in the Federal Reserve Bank in New York or the Bank of International Settlements at Basle to satisfy the official demand but without success. Diplomatic representations by Great Britain, Holland and France have been equally unavailing.

The case has attracted widespread attention because of the revelation it gives of the attitude of some at least of the Mexican government officials toward foreign capital invested in the country. This attitude has cost Mexico millions of dollars in lost revenue during the past ten to fifteen years and has been a principal factor in the drop of Mexico as an oil exporter from second to fifth place in the international field.

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Independent Stations Gain

PERSISTENTLY repeated has been the claim that the independent retailer of petroleum products in the United States was being forced out of business and that control of these outlets was passing into the hands of the large oil companies. Significant light is thrown on this subject by a special statistical report prepared for the Cole Committee and made public March 20.

Returns from companies representing 85 percent of the country's active refining capacity show that the number of outlets served on January 1, 1933 was 214,815 while on July 1, 1934 the total had increased to 219,382. During this same period the number of company owned and operated stations decreased from 25,429 to 24,470 or from 11.84 to 11.15 percent of the total. The number of stations company owned but operated by others increased from 8,009 to 10,574 or from 3.73 to 4.82 percent of the total. Stations wholly supplied by the reporting companies but independently owned increased from 181,377 to 184,338. In this period of a year and a half, therefore, a distinct trend away from the company owned and operated service station is distinctly observable and this, it may be mentioned, is a reversal of the tendency that had prevailed previously. The same trend is shown among both integrated and non-integrated companies.

Odds Against Oil Legislation at Washington

Extension of Recovery Act Expected to Be Followed by Revision of Petroleum Code—Labor Bills and Proposal to Break Up Integrated Organizations Causing Concern.

WASHINGTON, MARCH

WHILE there is more or less confusion regarding the general legislative program before Congress the outlook as it concerns the petroleum industry may be summed up as follows:

(1) Failure of the specific bills affecting oil that are now awaiting action, but continuation of production control through extension of the Code if none of these bills is passed.

(2) Drastic revision of the marketing sections of the Code with the elimination of provisions that have been found unworkable and with a possibility of attempted legislation to prevent a corporation from engaging in more than one branch of the business.

(3) Serious consideration by the Oil Administration of the report of the Petroleum Code Survey Committee on Small Enterprise as a guide to revision of the Code when the NIRA is prolonged by Congress.

On April 16 the Mines and Mining Committee of the Senate will begin hearings on the quotas-in-commerce control bill advocated by Senator Elmer Thomas of Oklahoma. These hearings are expected to be brief with Governor James V. Allred of Texas, bitter opponent of federal control, cast for the part of star witness. This bill has the active support of the Independent Petroleum Association, but even its friends do not expect that it will successfully run the Congressional gamut. If reported by the committee it may be passed by the Senate but almost certainly will be done to death in the House. The influence of the Cole committee which conducted an extended investigation of the oil industry last year will be exerted against permanent federal control. Representative Rayburn, chairman of the House Committee which will have charge of the bill if it reaches their side of the Capitol, and other influential Texans are known to be strongly opposed to the bill.

"The Texas fellows will not let the bill pass the House, even if we get it over there," says Senator Thomas. "Although I believe the majority of Texas oil operators are for it I am afraid that the bill will be strangled by inaction."

The same fate is believed to be in store for the bill by Representative Morgan Sanders of Texas to extend the so-called excise taxes on oil imports, and to increase the impost on crude from a half-cent a gallon to a cent. To get the excise taxes enacted originally oil tariff advocates worked out a deal with the representatives of coal and timber states, their combined strength putting the levies over. But there will be no deal possible this time, as bitter debate would prolong a vote for so long that legislative leaders probably will not permit the issue to be raised.

Although there is considerable dispute over the question, the Recovery Act will be extended. Congress may continue its shadowboxing and forensic fireworks for a few more weeks. Little real action may be taken before May, but in the end President Roosevelt probably will get what he wants, which is a two-year continuation of the fundamentals of the act.

It is a foregone conclusion that the extension will be limited to interstate and natural resource industries. Therein lies the real answer to what is most likely to be done about oil. Acting on the experience of the past twenty months the Oil Administration will strive for a revision of the production section to make it more efficient.

Some usually well-informed observers believe that there may be a strenuous effort by the Administration, if adequate oil control legislation is not enacted, to write what is wanted into the new code. Administration officials probably will seek to make allocations mandatory, as the federal agency has felt since the formulation of the original code that they should be.

Texas, represented by Governor Allred, then State Attorney General, and Chairman E. O. Thompson of the State Railroad Commission, succeeded in 1933 in providing that the allocations should be only advisory. They are maintaining a constant watch, in Washington and Austin, on the production section to see that it is not tampered with and any move to change it will bring an immediate fight.

Four other legislative matters are holding the industry's attention here: the Wheeler-Rayburn holding company bill, which is being closely watched to see what effect it will have on those companies that have public utility affiliates if and when enacted; the Wagner and Black labor bills, and the final recommendations of the Cole Committee.

The Cole Committee is adhering to its policy of waiting to see what the interstate compact movement will result in before bringing out one of the several drafts of bills in its possession or a combination of them. Until the Committee decides what it wants to do, no oil bill will go to the House for consideration.

The Wagner and Black bills, providing for a 30-hour week and that labor shall have equal representation with industry on code authorities, are being closely followed by members of the Planning and Coordination Committee and others here. The industry generally feels that the latter proposal would make each code authority a debating society and have a constantly disturbing effect on the situation. A 30-hour week is considered too expensive in the present state of the industry.

Serious consideration is being given by the Oil Administration to the multiplicity of recommendations just received from the Special Petroleum Code Survey Committee on Small Enterprise. This committee, appointed some weeks ago by Administrator Harold L. Ickes, filed its report during the last week in March, covering some forty pages in its findings. The report probably will be used by the Administration for guidance in revising the code.

The most revolutionary proposal is the one about which it is most difficult to predict Congressional action. This is the project to prohibit a single corporation from engaging in more than one branch of

the industry, and to require separate income tax returns from the various major divisions of an integrated company, viz: production, pipeline operations, refining and marketing.

These proposals were put forward in connection with violations of Rules 4 and 6, prohibiting sales for less than cost and requiring that profits in one branch be not used to offset losses in another. Special attention will be paid these rules, as set forth in the March issue of WORLD PETROLEUM. The general feeling is that they must be made workable or scrapped.

One word of cheer for the Oil Administration was found in this passage from the report of the special committee: "This Committee has become convinced that no permanent benefits of material value to either small or large enterprises of the petroleum industry can be obtained under the Code without a permanent, assured and effective balance of crude oil supply and demand, nor can stability of the industry and conservation of the oil resources of the nation be achieved without such balance." This was coupled with express support for adequate legislation to balance effectively the consumptive demand and production, with proper account made for limiting imports in accordance with domestic restrictions.

Major complaints brought to the attention of the Administration by the report are that the small refiner has been badly squeezed by too high crude prices and too low gasoline prices; that the present code organization, with its great number of local, state, regional and national committees is too cumbersome; that a smaller quantity lot discount be provided, and that price formulae reports be filed by the leading companies in given areas to help prevent price wars.

Although officials of the Oil Administration and the industry have not as yet had time to digest the extensive report of the committee, Administration officials hope that in the limited time remaining before June 16 when the present code expires something definite can be worked out to remedy the troubles which can be dealt with under the existing code.

On March 29 the administration produced a bill providing for the extension of N.R.A. for two years ostensibly to counteract a growing impression on the part of business that Congress would allow the N.R.A. to lapse on June 16. The bill was introduced by Senator Pat Harrison, chairman of the powerful Senate finance committee. Senator Harrison wished it distinctly understood that his bill was to serve merely as a basis for discussion and subject to substitution in whole or in part.

Apparently the administration felt that some action was necessary to get N.R.A. legislation started. The administration bill leaves Section 7A as it is, but attempts to modify the use of codes where these encourage monopolies.

The bill which would extend the life of N.R.A. for two years, in addition to re-enacting Section 7A in its present form, provides that codes must not sanction or encourage monopolies and further suggests tightening the injunction against conflict with the anti-trust laws. All licensing provisions are eliminated; those included in the present code have never been used. The oil, gas and coal industry come in for special mention as being natural resource industries which the President would be empowered to control through regulations applying to production, distribution and price whenever he deemed such control necessary in the public interest.

Labor's demand for equal representation on the code boards is overlooked but permission is granted to the President to impose limited codes with "fair and reasonable" wages and special working hours.

Groups of small industries could be included under one general code with the permission of the industries involved. A maximum size for the industries which are eligible for such blanket codes will be provided, based on the number of workers employed by such industries.

Administration of the revised code would continue in the same hands as at present. Assuring compliance with the provisions of the various codes by the use of distinctive insignia is mentioned but all reference to the blue eagle is omitted.

Violations of the code would be punishable by fine only and not by fine and/or jail sentence as at present. Employees are entitled to collect damages from employers whom they can prove have violated the minimum salary, maximum hour provisions of the code.

Finally all present codes would be extended for 90 days after their expiration on June 16.

The bill is certainly proving an excellent basis for discussion not only in Washington but throughout the country where business finds itself either "reassured" by the fact that the administration intends to sponsor further N.R.A. legislation or deeply discouraged by the prospect of another two years of uncertain and maladroit tampering with the business and industrial structure.

Naturally, with the bill subject to extensive revision, the chief significance of this move on the part of the administration, is as an indication of their determination to promote further N.R.A. legislation.

Swiss Gasoline Market

AN INTERESTING experiment in national planning for an oil market is now well under way in Switzerland. On the one side all importers holding import quotas, all wholesalers and all garagists and retail sellers have been joined together in the "Swiss Benzine Union" (S.B.U.). On the other side the consumers are organized into "Commission-Inter-Association" (C.I.A.) representing the principal consuming groups. These two bodies collaborate in setting up a "commission for supervising the gasoline market" (COSUMA). Members of COSUMA are elected proportionally by the S.B.U. and the C.I.A. Its function is to deal with questions affecting organization of the motor fuel market and to fix prices. The president of COSUMA is a neutral, and its decisions must be by unanimous vote. Gasoline prices are fixed in accordance with import quotations for gasoline at Swiss frontiers. COSUMA then proceeds to fix the inland selling price on the basis of the tank car price at the frontier and arranges for a division of margins between wholesalers and retailers, subject to approval by the Federal Cartel Price Authority. The filling station price is established by adding the wholesaler's margin of 4 centimes per liter, the garagists margin of 5 centimes, and the average transport cost of 1.28 centimes per liter. This arrangement assures a uniform price to the motorist throughout the country. The scheme went into operation May 22, 1934, and since then the same uniform price level has been maintained, a thing that has heretofore proved impossible in any other continental country.

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Norwegian Oil Trade

IN 1934 the census of automotive vehicles showed 61,696 units, comprising 33,378 touring cars, 21,114 trucks and buses and 7,204 motorcycles; there are 2,292 buses running over routes totaling 32,075 kilometers (21,384 miles).

Petroleum Imports in 1934
(in metric tons)

Products	1934	1933	1932
Gasoline	108,288	98,451	117,576
Fuel and Diesel Oil	301,890	279,660	191,872
Kerosene	35,677	34,064	25,841
Crude Oil	37,296	20,871	27,452
Asphalt	11,042	8,379	8,327

The use of oil for central heating is distinctly gaining. Importation of products listed above is exempt from customs dues, but various state and local taxes are levied.

Who Upsets the World's Markets?

An Oil Company Shareholder Examines Charges Made by "A Member of Soyusnefteexport" in the February Issue of World Petroleum and Decides to Retain His Capitalist Securities.

In reply to an article from the pen of a leading member of the official Soviet oil exporting trust, a London shareholder gives his views, based on everyday knowledge interpreted by common sense, on the responsibility for upsetting the world's markets—a charge that was formerly made against the Soviets who appeared anxious to gain a foothold in the world markets at any cost. This charge was vigorously denied by a member of Soyusnefteexport in an article published in the February issue of World Petroleum. World Petroleum is happy to be able to afford the same facilities to a shareholder of the capitalist companies as it has to the Russian trust. The accompanying article approaches the problem from an unusual angle, in taking the point of view of the ordinary shareholders of important oil companies.

LONDON, 11TH MARCH, 1935.

SIR,

As a "shareholder in oil companies" (outside Russia) I was much interested in the article from "a member of Soyusnefteexport" entitled "Who Upsets the World's Markets?" published in your February issue.

"A member" attacks statements made by Mr. J. B. Aug. Kessler in an article which, if I did see it, I have forgotten. A year is a long time to pass before an answer is given. It is not my intention here to take up the cudgels for Mr. Kessler; no doubt he is capable of defending his own case much better than I could hope to.

My interest is merely that of one belonging to that patient herd of people on whose backs apparently these battles are waged. My reaction, on reading "a member's" statements, was: "If he is right, then my money is in the wrong place. If so, does that mean that I should pull out of the private oil industry, or that I should entrust my money to 'a member,' always assuming that he would be open to such an offer?"

In trying to form an opinion on this, for me, important question, I have only been able to consult public statistics, therefore presumably facts. The value to me of my conclusions is enhanced because, having little knowledge of the inner workings of oil producers or marketers, I can afford to be dispassionate. I have never been rubbed the wrong way by competitive strife—at least, not knowingly—and my sympathies merely go where the best dividends are paid.

And now for the facts.

"A member" taxes the oil industry in America and Roumania with overspending. Taking his own figures: the U. S. has invested in the seven years 1927–1933, $4,800,000,000. The meaning of this statement is not very clear if one does not say what it is intended to produce with that money during that time and after. But if we pro rate this over the volume of oil produced in the U. S. in those seven years (6,249,833,000 bbl.) we find that, per million barrels of oil, the new investments amount to $768,000 or Roubles 1,489,920, using the rate of Roubles 1.94 to the dollar.

"A member" makes a similar statement about the investment in Roumania of 3.3 milliards of lei in the seven years 1926–1932. The oil produced during that time was 261,000,000 bbl. so that per million barrels of oil, the new investments amounted to Lei 12,643,678 or Roubles 146,678, using the rate of Lei 86.2 to the rouble.

For 1928–1934 (a period falling within and beyond the one in which the industry outside Russia is said to have overspent), I find from the figures appearing in various official Soviet publications that "a member's" organisation spent Roubles 2,726,000,000 and produced 937,637,000 bbl. of oil. Per million barrels of oil produced, this is an investment of Roubles 2,906,183 which is twice the amount of the U. S. and 20 times that of Roumania.

But this in itself is no indictment as long as the question has not been answered: "Will the investments in Russia, without a need of further increase, perhaps yield an appreciably larger quantity of oil than proportionate investments elsewhere?" Which is another way of asking if Russia's production is very much cheaper.

To answer this, I have turned to the figures available on Venezuela, a country producing a volume of oil comparable with Russia.

The particulars concerning countries like Persia and Mexico, as far as they are available (number of wells drilled and estimated depth), also show Russia to be less efficient.

From the table it appears that the expenditure on drilling in Russia—one of the heaviest items of capital investment is very much higher than where private companies operate.

It therefore seems that "a member" has conveniently assumed what he set out to prove and that he has no case. And if it were possible to add colour to something which does not exist, it could be provided by the speech made by "a member's" comrade, G. Lomoff (member of Commission of Soviet Control), published in the Soviet paper IZVESTIA on February 4, 1935. He says:

> "On drilling alone, we spend only one quarter of the time spent in America, and drill 10 times less."

To a secular mind like mine, this means that to drill the same depth as in America, 2½ times the number of hours (therefore labour and interest on plant) are required in Russia. And then this same Com-

Drilling Results in Russia and Venezuela

	Russia			Venezuela		
	Footage drilled	Production Tons	Tons per ft. drilled	Footage drilled	Production Tons	Tons per ft. drilled
1930	2,098,216	18,376,000	8.76	1,040,475	20,191,270	19.41
1931	2,320,151	22,334,700	9.63	228,802	17,303,690	75.63
1932	2,468,006	21,397,000	8.67	142,586	17,085,278	119.82
1933	2,748,938	21,440,000	7.80	368,200	17,293,193	46.97

rade, in the next breath, complains about the low rate of increase in production. Apparently he can't have it expensive enough.

A great deal of trouble has further arisen between "a member" and Mr. Kessler, about the latter's indictment that Russia was dumping. We may or we may not get that clear. I am more interested in the blame they lay on each other for the low prices that affect the dividends, by which I measure whether my investments are good or bad. After all, I am only the shareholder.

All I know is that the companies which have some of my money, and which produce oil at something like one-fifth or one-eighth of the cost of that in Russia, judging by the figures given above, do not seem to be able to earn enough at current oil prices to pay me more than a very (in fact too) modest interest.

Mr. Kessler is said not to have compared like with like and to have "framed up" a case of dumping. The correct definition of dumping is "selling at a high price at home and securing there a profit which enables one to sell at a low price for export." Therefore, if "a member" denies dumping, it is quite clear that out of the goodness of his heart, he is making everyone who gets his oil a handsome present. If that is so, "a member" is entirely right when he says that Mr. Kessler's concern about the consumer in the Soviet Union, loses any point it otherwise might have had.

But all this is rather by the way, and to me of indirect interest, inasmuch as some of "a member's" statements do not seem to stand scrutiny too well.

For me the most important point he makes is this. He lays at the door of non-Russian oil interest in general, and in particular of the concern with which he identifies his critic, the responsibility for causing low prices by "the keenest aggressiveness" against, and desire of "unlimited expansion" at the expense of, Russian oil exports.

In other words, in their wish to oust the Russian oil from its share in the world's markets, legitimately acquired and held at a price level which was economically and commercially justified, the other oil interests have reduced prices. It is their insatiable desire for the other man's share of the trade which is responsible for my low dividends.

This is "a member's" most important statement. If it is true, he deserves my thanks, and no doubt those of many others similarly involved, for the timely warning that I have put my confidence as well as my money in the wrong place.

I found the following figures, however, rather illuminating:

	Russian Exports M. tons	Yearly Increase %	World Production M. tons	Yearly Increase %
1924	723,200		138,982,000	
1925	1,342,200	85.6	146,483,000	5.4
1926	1,473,700	9.8	150,527,000	2.8
1927	2,066,100	40.2	172,816,000	14.8
1928	2,727,300	32.0	181,541,000	5.1
1929	3,642,000	33.5	203,389,000	12.0
1930	4,623,200	26.9	194,399,000	−4.4
1931	5,277,400	14.2	186,964,000	−3.9
1932	6,011,300	13.9	179,136,000	−4.2

This shows that the Russian exports increased most markedly during the time when the total world production increased at a much smaller rate and when the non-Russian oil industry was supposed to be overspending (as "a member" wrongly stated). But even earlier (before 1926) we see something which resembles desire for unlimited Russian expansion. Where Russian oil increased its share in the world's markets, the non-Russian must have suffered a reduction.

Under what conditions would any industry accept, and possibly be justified in accepting, a loss of its markets? I would say that economically as well as commercially the answer must rest on three premises about the competition in question:

1) That supplies of equal quality are plentiful so as to establish certainty of continuity

2) That the source of supply is geographically such as to make it competitive

3) That the financial strength is adequate.

Of these three criteria, only one—the first—is possibly met in the Russian case.

The second is destroyed by "a member," who complains about the price level in China, India, S. Africa, New Zealand, Japan, Sweden and England.

My information is that into all these markets, Russian oil has found its way to a larger or smaller extent. This has happened in spite of the fact that in some cases the freight alone from the only Russian export harbours (the Black Sea) has exceeded by 20 percent of the world market f.o.b. price, the freight from the point of supply which is geographically the most economical source for such markets. Add to this the proved higher production cost which I have illustrated above, and the faintest belief in logic rules out the third factor—financial strength.

So much for keen aggressiveness and unlimited expansion on the part of the private oil industry.

There still remains the question of actual price tactics, although this point has practically been dealt with in showing that, so far as private industry resorted to low prices, this was needed in self-defence.

I do not know to what extent the knowledge of the marketer, which I lack, can add weight to my experience as a man in the street. Buy on my travels the cheapest oil products I meet are almost invariably Russian, frequently admitted as being sold on consignment—therefore at whatever price they can fetch.

Added to this, there appears in the press sporadically, news of important contracts which the Spanish monopoly concludes with Russia for oil products, at prices stated to be anything between 10 percent and 18 percent below world market prices. From this it appears that Russia's primary interest is the import of foreign currency and that their oil exports are merely a means to that end and therefore divorced from any commercial considerations.

"A member" quotes the gold rouble prices at which Mr. Kessler alleged that Russia was selling, and compares them with the gold rouble equivalent of Gulf and Constanza prices.

It would seem to me that Mr. Kessler could have made a better case, because, judging by what has been said above, the Russian export prices which he mentioned and which "a member" does not criticise as being too low, could, in my opinion, never have been reached.

And now, Sir, I have come to the end of my search as to whether I should be better advised to withdraw my oil investments from where they are at present and offer them for investment in "a member's" organisation (always assuming that such a proposal would be favourably received).

I am grateful to "a member" for having settled this problem for me to my entire satisfaction, and although if it were not combined with certain personal inconvenience I might still like to be associated with "a member's" organisation as a consumer in Russia, on account of the exceptional treatment I should get, I have the honour to be, Sir, and remain, as before.

A SHAREHOLDER

I. F. S. to Encourage Domestic Refining

Probable Reduction in Employment without Compensating Factors Likely To Result From Irish Policy. Glasgow Method of Awarding Contract for Petrol Purchase Criticised.

DISCUSSIONS between the major oil groups distributing in Southern Ireland and the Free State Government have failed to produce any appreciable modification of the government's plans for stimulating home production of motor spirit by the grant of a duty preference of 2d. per gallon. It may therefore be taken for granted that the new policy, which has already become effective, will follow its natural development, although its ultimate results are likely to be very different from those intended by the Irish authorities.

By charging only 6d. per gallon excise duty on spirit produced in the Free State, against an import duty of 8d. per gallon, the government hopes to see home output eventually increase to 35,000,000 gallons annually and thus meet the full requirements of the country. Spirit produced under the 2d. per gallon preference is expected to be saleable to the public at a price slightly below that charged for imported spirit. This price advantage, with a government-fostered inclination on the part of the public to support home products, would doubtless be sufficient to keep out imported spirit to the extent that the Irish refining industry is able to meet the demand.

It is not to be expected, however, that The Texas Corporation, operating through The Texas Company (Ireland), Standard of New Jersey, through the Irish American Oil Company, and the Shell and Anglo-Persian, through Irish Shell Limited, will allow their products to be ousted from the Irish market through inattention to the growth of an internal refining industry. Transfers of manufacture from outside to inside tariff barriers are a normal development of modern industry of all types, and it is a reasonable assumption that the oil distributors in Southern Ireland would prefer refining within the country to relinquishing their share of the market they have developed. The government fully intends that they should set up their own refineries in Ireland.

As pointed out in the February issue of WORLD PETROLEUM, the Free State market in its present stage of development provides a relatively small outlet for petroleum products, and offers insufficient scope to justify the establishment of an independent refinery by a major oil group. A combine of the oil groups for refinery purposes is thus the logical means of overcoming the difficulties created for existing distributors by the Free State preference.

With the source of motor spirit centralised through the possession of a common refinery, it would be a very short and equally logical step to a complete merging of the whole of the Irish distributing organisations of the participating groups.

Each of these groups at present maintains its own separate distributive system, and the total of persons thus employed is about 1,500. If, as is quite possible when Ireland's home refining plans are more fully developed, these groups were to amalgamate their complete Irish business, the loss of employment would be far greater than any gain which could be expected to result from the extension of refining. Carried to its full length, therefore, the home refining policy of the Free State seems certain to defeat its own ends.

Aside from the employment question, which is the main argument for Ireland's change of policy, the need for an improved balance of overseas payments has been put forward as a reason for stimulating local motor spirit refining. But there is little to be gained from the proposed change on these grounds, for motor spirit is the only product of refined crude which enjoys an extensive market in Southern Ireland, and the development of export markets for other refined products is one of the difficulties which the preference scheme will bring in its train.

In the absence of a profitable overseas market for petroleum products other than motor spirit, internal refining in Ireland would be uneconomic. Crude brought into the country for refining would have to bear the cost of unprofitable disposals of part of its contents, and would therefore be in danger of costing Ireland as much in the long run as the motor spirit which is now being imported, with no benefit to the country's overseas trade position.

Questions of the disposal of extraneous products are doubtless met in the case of the new Haulbowline plant by the connection of Cork Harbour Oil Wharves with the Lobitos and Anglo-Ecuadorian Companies, with their outlet in England and elsewhere. Similarly, the oil groups already operating in the Irish market would have good prospects of putting products other than motor spirit to profitable use outside Ireland. But, as already shown, refinery operation in their case has every prospect of being a joint undertaking, with the almost certain corollary of joint marketing and a corresponding decline in Irish employment in the handling of motor spirit.

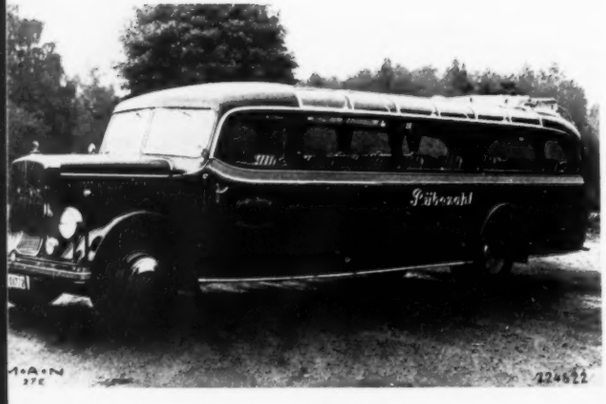
Recent events in Glasgow provide a curious contrast with the Irish position. If the Free State Government has evinced excessive "economic nationalism", Glasgow's Socialist-controlled Corporation has erred in the opposite direction. Tenders were invited for the supply of 3,000,000 gallons of motor fuel, representing a year's requirements of the Corporation's transport services, and the "national" group, including Scottish Oils and Shell-Mex Limited, Anglo-American, and Redline-Glico, lodged alternative tenders of (1) motor spirit at $11\frac{7}{16}$ d. per gallon for the whole amount, or (2) 1,000,000 gallons Scottish traction naptha at $10^{11}\frac{1}{16}$ d. and 2,000,000 gallons motor spirit at $11\frac{7}{16}$ d. After a long period of negotiation, during which the Corporation put forward numerous new stipulations which were met in a perfectly reasonable way by the "national" group, the contract for supplying the whole amount required was placed with Russian Oil Products at $11\frac{7}{16}$ d. per gallon, a figure below the original R.O.P. tender price.

This decision has aroused intense local indignation, and it has been alleged, apparently with good reason, that the sanctity of the sealed contract system was broken by the Corporation, and the "national" tender used as a negotiating instrument for obtaining a lower offer from a competing undertaking. There is no suggestion that the part taken in the deal by R.O.P. transgressed business morality in any way, and the fault is laid at the

(Continued on page 201)

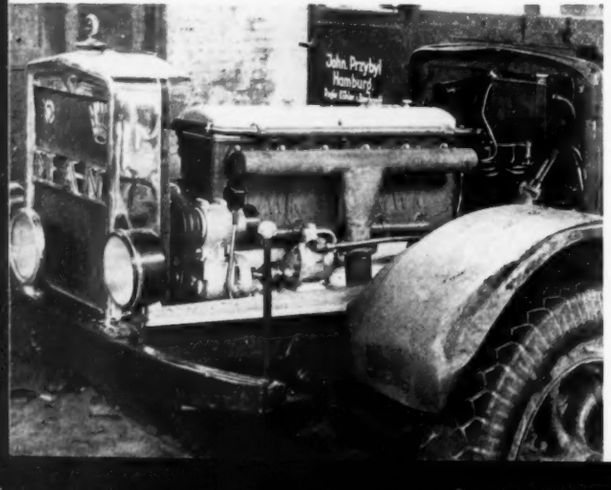
Daimler-Benz Diesel road tanker which has covered 100,000 km. carrying 4,600 litres (3½ tons) pay load in the service of Olex Deutsche Benzin und Petroleum Ges. A.G. of Berlin.

Diesels Predominate at Berlin Motor Show



Ninety horsepower, six cylinder M.A.N. Diesel bus.

Conversion from gasoline to M.W.M. Diesel power in a German truck.



Over Ninety Percent of Commercial Vehicle Exhibits are Oil-Engined. Extensive Turn Over from Gasoline Significant. Effect on Refining and Taxation Must Soon be Felt.

By T. Orchard Lisle

As a DIESEL enthusiast from the time the first sea-going tanker was fitted with an oil engine, namely in 1910, my interest was keenly aroused when a week ago the executive-head of one of the largest oil companies in the world informed me that last year he was greatly impressed with the great showing of Diesel vehicles at the Berlin Motor Show, and consequently urged me to attend the current exhibition and study the tremendous development in transportation power now taking place. Nevertheless, I was not fully prepared for the big engineering strides that have lately been made in Germany with the high-speed commercial vehicle Diesel, or for the complete nation-wide acceptance and adoption of this form of power. Over 90 percent of the trucks and busses are Diesel driven, varying in power down to the little Primus four-wheeled "horse" that has a two-cylinder Deutz engine of 25 h.p., and sells for RM. 3,150 (about $1,100).

This Berlin Motor Show probably is the biggest and most successful ever held in any country, and the city is crowded with visitors. There is an enormous number of exhibits, filling no fewer than eight large halls, of which some have galleries. Apart from private cars and accessories, there are huge sections for commercial vehicles and motorcycles. If the tre-

mendous interest displayed is any criterion of the actual purchasing, then the German automotive industry will have a very excellent business year.

The Diesel element becomes apparent immediately entering the Hall of Honor at the Berlin Show, for displayed singly on pedestals are vehicle-Diesels by Krupp; M.A.N.; Junkers; Daimler-Benz; Humboldt-Deutz; Maybach; Magirus; Vomag, and Bussing-Nag. These engines apparently are placed there as a symbol of this new German industry, and are unattended. I use the term "new", not in the sense that the Diesel is new to Germany, for it was a German engineer of that name who gave the Diesel to the world; but, because its commercial development and adoption in weights and speeds for road vehicles to the point of almost completely displacing gasoline power is very recent. Most of these engines follow conventional design, and a close look has to be given to differentiate them from ordinary gasoline units. One engine in the Hall of Honor is a departure from regular practice; this is a 320 h.p. Bussing-Nag motor designed to operate on butane and propane, and which has two crankshafts and two sets of cylinders in parallel. One striking engine, which illustrates just how far standard design has gone is the M.A.N. 12-cylinder, V-type unit for a rail car, developing 420 b.h.p. at 1400 r.p.m. Then in another hall is the Junkers opposed-piston type motor. The inventor of this design of Diesel, Professor Junkers, also famous for the aeroplane of the same name, died quite recently.

One must pass through the commercial vehicle halls to obtain a true picture of the great advance that has taken place, for here hardly a gasoline truck or bus is to be seen. I also only noticed one Diesel-electric vehicle, namely an A.E.G. bus that has been running on the Berlin streets in an experimental way. The A.E.G. are now developing their own high-speed Diesel.

From an engineering point of view, perhaps the most interesting chassis was that for a streamline bus of large carrying-capacity. This chassis has a 145 h.p. Bussing-Nag Diesel engine at each end, with the drive from each engine on one of two sets of somewhat centrally located rear wheels.

All engines are not of conventional design, as Krupps of Essen have a number of vehicles with horizontal opposed-piston air-cooled Diesels, as well as the Junkers vertical type opposed-piston motor; while Vomag have an eight-cylinder 185 h.p. horizontal engine, the consequent height of which is very low for the output of power.

One company is specializing in the replacing of gasoline motors with M.W.M.

This Opel-Blitz gasoline light truck was converted with a 50 h.p. M.W.M. Diesel engine.

•

Three ton M.A.N. Diesel bus in the German mountains.

Vomag-Lastwagen mit reinem Holzgas 25000 km.
Internationale Alpenwertungsfahrt 1934
Schwerlastzug-Betrieb · Winterwettbewerb 1935

Increasing numbers of Gasogenes (wood gas burning vehicles) are appearing on the German highways.

•

Bussing-Nag Diesel road tanker for Iran designed to carry water for the Shah when he travels.

Diesels without any substantial changes to the chassis. The cost for 50 h.p. is about RM. 3,400, or RM. 7,400 for 135 h.p.

The well-known firm of M.A.N., at which works the Diesel engine was originally developed by Dr. Rudolf Diesel and Dr. Immanuel Lauster, have no fewer than 25 engines and vehicles on exhibit, including three railcar Diesels.

Out of a total of 68,760 commercial vehicles of over 2½ tons registered in Germany on 1st July, 1934, no fewer than 12,000 have Diesels, and the number is increasing very rapidly as the construction of gasoline-driven trucks and busses has practically ceased. Of new vehicles registered last July the Diesel percentage was 75 percent, as compared with 65 percent in 1933 and 45 percent in 1932, so the speed of growth is obvious.

The reason for this swift development is understood when it is mentioned that today oil fuel costs in Germany are 78½ percent less than the benzine-benzole mixture used by gasoline trucks, while the cost of operating and maintenance are no higher.

▼

French Trade Faced With Huge Stock of Alcohol

An Exceptionally Productive Agricultural Season Has Created a Difficult Situation for the French Government in Disposing of Alcohol Output—Some Possible Solutions. ***By H. O. Beatty***

JUST what steps are to be taken to dispose of the 1934 output of alcohol in France is a problem which is taxing the ingenuity both of the government and private industry alike.

It was realized at the end of the harvest season of 1934 that the distillation of alcohol would far exceed that of any previous year, yet it was thought that when the very liberal estimate of 4,800,000 hectoliters was made, the ultimate result ought to prove to be well within that figure. The favorable conditions, however, which produced the unexpected yield in sugar beets, produced equally unexpected results in the yield of other products of the soil as well. France has never seen such a crop of grapes as was gathered last fall. The prodigality of nature became a source of such grave apprehension to the vineyardists that they were forced to appeal to the government for aid in order to find an outlet for15,000,000 hectoliters of wine which must otherwise remain a dead loss upon their hands. After several weeks of debate in the Chamber of Deputies, the vineyardists were finally authorized to distill their wine into alcohol which the government agreed to buy at the fairly remunerative price of Fr. 350 per hectoliter. The addition of the alcohol thus acquired, together with a smaller amount bought to help out the cider interests, materially swelled the amount of the original estimate, so that the actual figures on the alcohol stock for the present year, which have now been ascertained, show the following definite results:

	Hectoliters
Alcohol derived from beet sugar =	2,800,000
Alcohol derived from molasses =	1,000,000
Alcohol derived from wines =	1,500,000
Alcohol derived from cider =	125,000
Total =	5,425,000

As has already been pointed out in the February issue, there are a number of industries, quite aside from petroleum, which are regular consumers of alcohol. The more important are those having to do with the manufacture of wines and liqueurs, vinegar, chemical and pharmaceutical products which, with certain small consumers, represented heretofore an average annual absorption of some 1,100,000 hectoliters of alcohol. The general slackening of trade conditions, however, has been manifested in these branches, as in all others, so that their requirements will not take at the outside more than 1,000,000 hectoliters of alcohol during 1935. There will thus be left 4,500,000 hectoliters to be absorbed by the Service des Poudres and the oil industry, which latter will be obliged no doubt to assume much the heavier burden.

As a matter of fact there was delivered to gasoline importers to be mixed with pure gasoline 2,470,000 hectoliters. This excess of 370,000 hectoliters was drawn from the general alcohol stocks of the Service des Poudres for which it had no immediate need. Nevertheless its absorption will, to a certain extent, have a beneficial effect by aiding importers in the disposal of the extraordinary quantity on hand this year.

Disposal of French Alcohol 1934

	Hectoliters
Total alcohol purchases of the Service des Poudres	3,200,000
Deliveries to industries other than that of Petroleum	1,100,000
Amount remaining for employment in gasoline compounds	2,100,000

When we speak of the alcohol delivered to gasoline importers, it must not be understood that the term "importer" is restricted only to those engaged in shipping pure gasoline into France. It is applicable to any dealer acquiring the refined product, whether by importation from abroad, or by purchase from domestic manufacture. The *modus operandi* adopted by the government in liquidating its stocks of alcohol destined to be blended with gasoline has been to require the importer to buy monthly varying percentages calculated on the amount of gasoline delivered to him either on direct importation or purchased locally from a French refinery. The minimum percentage fixed by the law is 10 percent. The percentage expected to be applied this year will be 12 percent. The refiner, as such, is never obliged to purchase alcohol from the government. He merely refines gasoline from the crude oil that he has imported and stores it in his tanks which are placed under bond to the Customs Service. The obligation to purchase alcohol arises only at the moment when delivery is made to the buyer from the gasoline held in bond

and attaches to him alone. By general acceptation he is known as an importer.

The jump from 2,100,000 hectoliters of alcohol to 4,425,000 hectoliters was a rather staggering blow to the oil trade since its employment in connection with the sale of gasoline is compulsory. So apparent was the crushing weight of the burden that the Service des Poudres decided to relieve the gasoline distributors of a certain part of this excess. It has, in consequence, undertaken to establish a reserve stock for itself and has signified its intention to demand of the oil industry the withdrawal of no more than 3,500,000 hectoliters. While this is unquestionably an immense help, it does not by any means resolve all of the problems confronting the trade for the coming year, nor calm the anxieties resulting from the falling off in consumption. These very justifiable anxieties are rendered the more acute by reason of the self-evident fact that the one million and more extra hectoliters of alcohol which the oil industry will still be forced to dispose of, will deprive it of the sale of a like amount of gasoline upon which a most desirable profit might have been realized. The price fixed for alcohol withdrawn by the importer is determined in such a manner that there will be neither loss nor profit consequent upon its resale as a motor fuel.

In seeking remedies for this difficult situation the mind turns first to inquire whether there is nothing to be done looking toward the development of the industries normally employing alcohol so that their requirements for this material may be increased. Of such industries the most important and the most promising appears to be that of perfumery. It is important for two reasons. In the first place, it is one of the great national enterprises and, as such, is entitled to every possible stimulus that can be given it in order to help it recover from the blow that it has suffered through the loss of the larger part of its export trade. In the second place, it is the largest potential natural consumer of alcohol among the private industries of the country. Tariff walls and quota regulations were the first measures to affect its flourishing trade. Later, when the countries of South America put embargoes on the exportation of capital, its foreign business practically came to an end. So far as the local market is concerned, economic conditions have curtailed its sales to a marked degree.

The price demanded of the perfumer on his alcohol purchases is Fr. 500 per hectoliter as against the minimum paid by the gasoline importer of Fr. 112. The range of difference between the two is sufficiently wide to presuppose a margin whose latitude would permit an appreciable reduction in price on alcohol entering into the manufacture of all varieties of cosmetics and perfumes, especially eau de cologne. Nor would it be unreasonable to assume that the government would suffer no great loss in the end by consenting to a substantial diminution of its prices. Indeed, it is quite possible that it would gain by the operation, at least indirectly, since any increase in the volume of sales would procure a corresponding increase in the state's revenues through the additional collection of taxes thereon. Furthermore, it should not be overlooked that such a policy ought to be productive of advantage to the community at large. Similar reductions of price might be made as well, and for the same reasons, to other branches of industry mentioned above with equally desirable results, notably, for example, in the manufacture of chemical and pharmaceutical products whose cost to the prospective retail purchaser is now so high as to deter many who would be otherwise inclined to buy.

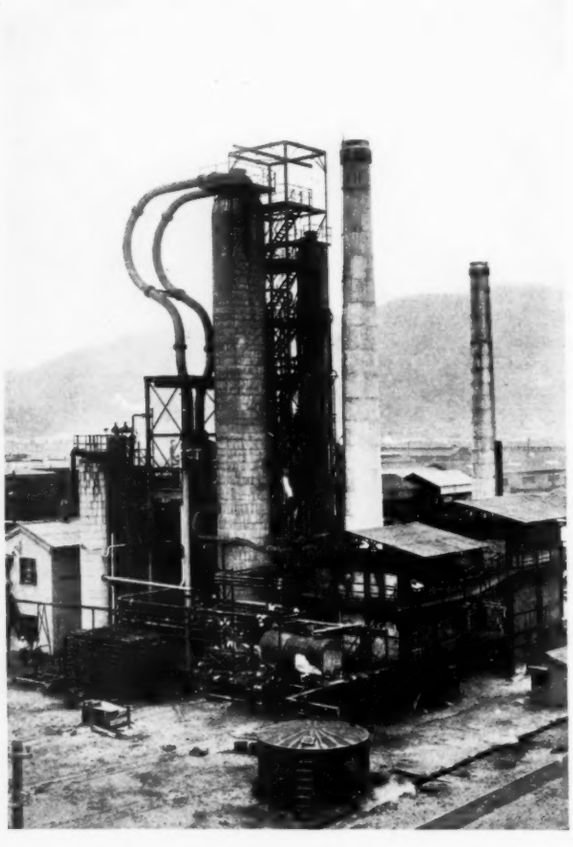
It would undoubtedly be dangerous from the point of view of national defense to attempt to place a limit on the acreage to be planted in beets or to define too narrowly the quantities of alcohol to be distilled therefrom. Yet it seems none the less the part of wisdom to reduce materially the distillation of alcohol derived from molasses. This could be accomplished not only without endangering the interests of the nation, but with desirable results viewed from a general economic standpoint. Much of the molasses now transformed into alcohol was formerly employed to fatten livestock. Its diversion from that useful end has played a noticeable part in advancing the retail price of meat and in thus contributing to the increased cost of living. A restrictive limit placed on the amount of alcohol to be produced from molasses would obviously restore it to the uses for which it was formerly marketed. It seems to us incontestable that whatever will tend to reduce the cost of living must inevitably react to the benefit of all national activity. Certainly if it operated only toward a reduction of the amount of alcohol destined to be blended with gasoline, it would still represent a source of immense profit to the national treasury by reason of the augmentation of its tax receipts.

It may be assumed also with apparent reason that the determination of the Service des Poudres to withhold from this year's distillation of alcohol an amount of 1,000,000 hectoliters to be used for the purpose of establishing a reserve over and above the supply necessary for the current manufacture of explosives, is an indication that an emergency stock is held to be a wise precaution with respect to the national defense. What quantity might or might not be needlessly large in this connection, we have no means of guessing. Nevertheless the government could profitably constitute a reserve that went even well beyond the limit of any eventuality which can reasonably be foreseen. Every liter of alcohol sold to the importer for blending is a net loss to the state. Its conservation, therefore, would be a net gain as well as an insurance against the possibility of an unexpected need. The unusual conditions of this year logically appear to offer every inducement for the inauguration of such a policy. It is wholly improbable that we shall see two consecutive years of such abnormal agricultural production as the two immediately behind us. Even though the yield in sugar beets may be found next fall to be comparable to that of last year, it would be astonishing to witness two successive grape crops of such huge proportions. It appears likely that next year the distillation of alcohol will have returned to practically normal figures.

We have said that the government would realize a gain in conserving its alcohol purchases. Indeed we might go still further and say that yet a greater gain would be procured if these stocks were to be destroyed completely. Of course the idea of a voluntary and wanton destruction of matter created by months of arduous labor and acquired through purchases made with money earned under conditions of exceptional difficulty is obnoxious to our sense of economic proportion. None the less the figures are there before us, and no amount of argument can explain away their painful truth. The Chairman of the Finance Committee of the Chamber of Deputies reported to the Chamber during the debate on the measures proposed for the relief of the vineyardists that the taxes paid to the state on gasoline amount to Fr. 209.40 per hectoliter. The average price received by the government on the alcohol withdrawn by the gasoline importers is 135 Francs per hectoliter, or a loss of 74.40 Francs on each hectoliter of gasoline replaced by alcohol. If, therefore, the 3,500,000 hectoliters of alcohol destined to be disposed of through the agency of motor fuels were to be destroyed the state would be a gainer thereby to the extent of Fr. 245,000,000. It is for this reason that we say that the greater the reserve stocks of alcohol which may be established, the more profitable it is believed that the operation would prove in the end to be with respect to the national economy. And it is toward the application of such remedies as we have outlined above that the attention of the oil industry is now directed.

Nippon Oil Company's refinery at Tsurumi, near Yokohama, Japan.

Foster Wheeler distillation unit at Shimomatsu, Japan.

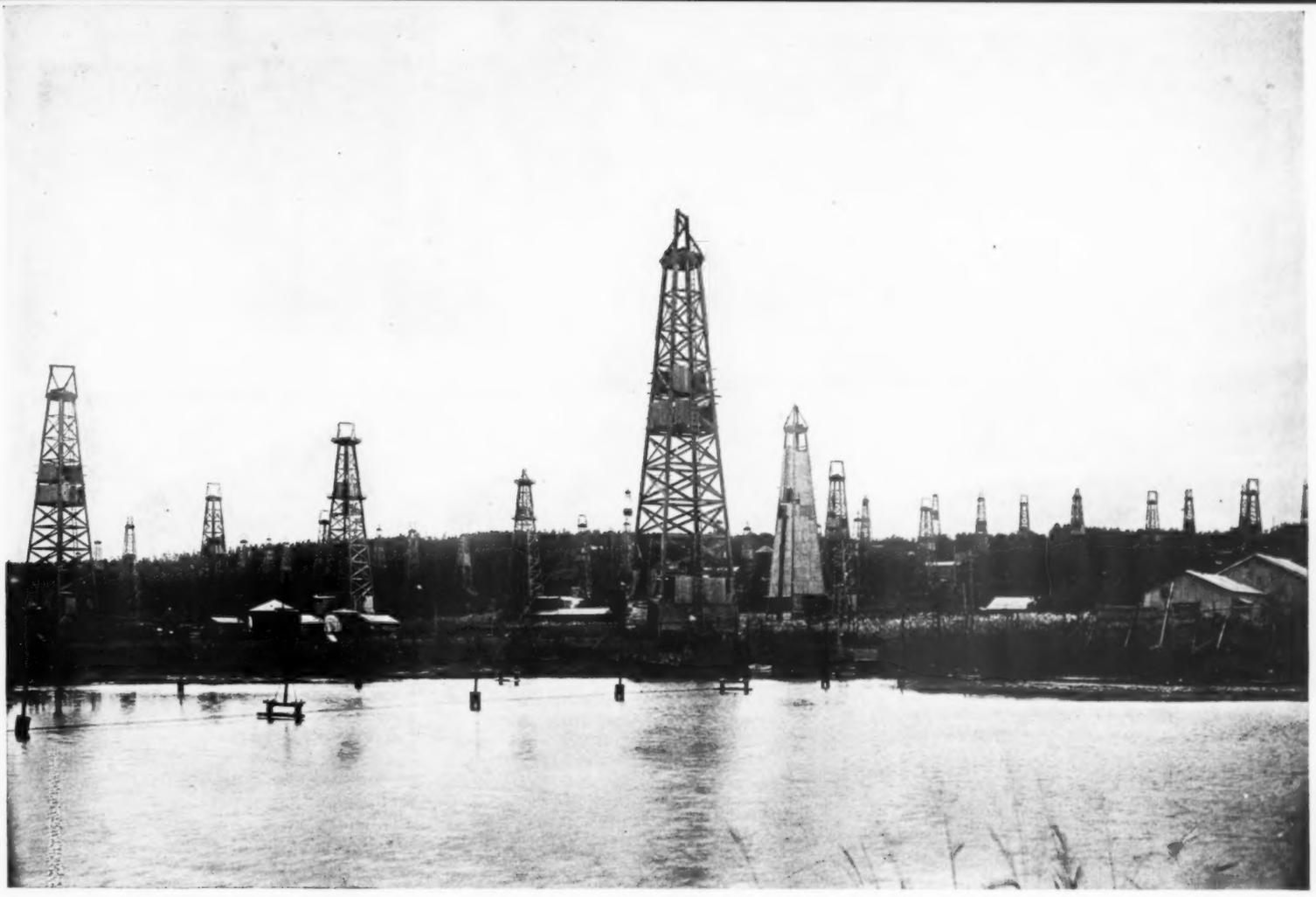


Japanese Market Facing Improved Conditions

Authorization of Higher Gasoline Price and Establishment of Import Quotas Pave Way for New Cartel and Better Earnings — International Companies Still Dissatisfied with Allotments

TOKYO, MARCH 1935

IMPROVED conditions for the petroleum trade in Japan are promised by recent and pending developments. One of these is the authorization by the government of a higher price for gasoline, effective Jan. 1, 1935. Another is the establishment of import quotas for the current year. These quotas favor native companies and while the authorities have



Kashiwazaki oil field, Niigata Prefecture, Japan.

granted small increases to the companies controlled by outside capital these are not satisfactory to the latter considering the anticipated growth in total consumption. The third is a movement on the part of the native companies to revive the cartel which was broken up following the promulgation of the oil law of 1934.

Sellers of gasoline originally asked for a restoration of the price of 50 sen per gallon which was the standard quotation before the failure of the seven company agreement in 1934. Subsequently they modified this to a request for an initial advance of five to six sen. The government's decision, however, was to permit a rise of 3.5 sen, from 40 to 43½ sen per gallon. While this increase is in the nature of a part loaf it will contribute toward bettering the earnings of the oil companies. Domestic consumption is from 270,000,000 to 280,000,000 gallons yearly. Addition of 3.5 sen to the sales price therefore will bring an increased annual return of from ¥9,700,000 to ¥9,800,000.

The increased earnings of the Nippon Sekiyu K.K. (Japan Oil Company, Ltd.), the biggest oil concern in Japan, will amount to about ¥2,000,000 a year.

It should be noted also that the standard quotation of 40 sen a gallon for gasoline before the government approved the 3.5 sen rise was more nominal than otherwise, the actual market price at filling stations in many instances being only

A refinery at Kashiwazaki, Niigata Prefecture, Japan.

about 38 sen. Should the market price be strictly observed this year, the actual increase in returns from sales of gasoline will reach ¥12,000,000.

In view of previous examples in which retail price agreements frequently proved unsuccessful, the oil companies apparently are planning to enter into a special agreement for the wholesale price of gasoline in attempting to raise the quotation by 3.5 sen to 38.5 sen. It has also become known that the oil companies are considering applying for another advance in the gasoline quotation.

Although the second advance in price, if effected, will be small, prospects for such a rise serve as an encouraging factor in Japan's oil industry.

What the Ministry for Commerce and Industry is concerned with at the present time is only gasoline. The advance in its price, however, naturally will operate to strengthen the market prices of other oil products, such as heavy oil, light oil, machine oil and kerosene. Thus any change in the price of gasoline will affect other oil products. Often in the past, fluctuations in the market prices of oil products were based principally on gasoline. So, if the present advance in the gasoline price should be repeated in the future, it is certain that the market quotations of other oil products will tend to rise under such action.

The fact that sales quotas for different oil companies will be applied not only to gasoline, but also to other oil products is another factor to encourage the Japanese oil industry. It is obvious that sales competition by underselling becomes meaningless when the sales quotas of the different companies are adhered to.

Oil sales quotas for the year 1935 were announced by the Ministry for Commerce and Industry on December 27 last. The new sales quotas have two special features worthy of attention. The first is the application of a quota to all oil products other than gasoline; the second is the special consideration given to the natural increase in the sales of international oil companies operating in Japan. A sales quota system was adopted following application of the new oil law which became effective in July, 1934. One of the principal objects of this law is to protect domestic oil capital and it was planned by the authorities to give the lion's share of the annual natural increase in domestic consumption to oil companies having Japanese capital. It should be noted that the annual natural increase in gasoline consumption alone amounts to 5,000,000 cases or 45,000,000 gallons.

From 40 to 50 percent of the manufacturing capacity of leading oil companies in Japan, such as Japan Oil, Mitsubishi Oil and Ogura Oil, is said to have been idle, and a sales quota based on the principle of protecting domestic companies would benefit them principally. The international companies operating in Japan protested that the adoption of such a "patriotic" measure would deprive them of their prospects for further expansion. In opposition to the oil law they even withdrew from the seven-company agreement. As a result of later discussions they apparently have agreed to withdraw their protests if proper consideration were given to their market position in the assignment of quotas.

At any rate the authorities, in deciding upon the 1935 sales quotas for gasoline, allowed practically one-third, or 45,000 kiloliters, of the estimated annual increase of 150,000 kiloliters to the foreign concerns.

Details concerning sales quotas for 1935 are given herewith:

GASOLINE: Gasoline consumption for 1935 was estimated at 1,150,000 kiloliters, based upon the 1934 consumption of 1,000,000 kiloliters plus the estimated natural increase of 150,000 kiloliters. Of the 1,150,000 kiloliters, 1,000,000 kiloliters were divided among the oil companies, domestic and international, on the basis of their actual sales during 1934. Of the remaining 150,000 kiloliters, 105,000 kiloliters were allotted to domestic refiners to stimulate the activities of their idle refining facilities, and 45,000 kiloliters were given to the importers. The 1935 quota was divided into 583,000 kiloliters for refiners (domestic companies) and 567,000 kiloliters for importers.

KEROSENE: Consumption for 1935 was estimated at 140,000 kiloliters, the sales quota being divided into 835,000 kiloliters for refiners and 650,000 kiloliters for importers.

LIGHT OIL: Consumption for 1935 was estimated at 200,000 kiloliters, the sales quota being divided into 191,000 kiloliters for refiners and 9,000 kiloliters for importers.

MACHINE OIL: Consumption for 1935 was estimated at 290,000 kiloliters (1934 consumption, 250,000 kl.; 1935 natural increase, 40,000 kl.), the sales quota being divided into 252,500 kiloliters for refiners and 37,500 kiloliters for importers.

CRUDE OIL: Consumption for 1935 was estimated at 1,270,000 kiloliters (1934 sales 1,100,000 kl.; 1935 natural increase, 170,000 kl.), the sales quota being divided into 183,000 kiloliters for refiners and 1,067,000 kiloliters for importers. The remainder of 20,000 kiloliters was reserved for direct importation by consumers.

Following the 1935 sales quota decisions, Japanese oil interests apparently desire to re-establish the oil agreement which has been ineffective since the middle of 1934 following the withdrawal of importing companies operating in Japan. Two strong oil cartels are in view at present. One is the six-company agreement and concerns only gasoline. The other is the establishment of a union to control the supply of crude oil, machine oil, kerosene and other products aside from gasoline. The six-company agreement indicates a cartel controlled and protected under the Principal Industries Control Law, for which only those companies having monthly sales exceeding 100,000 cases are eligible. Nippon Oil, Ogura Oil, Mitsubishi Oil, Matsukata Oil, Standard Oil and Rising Sun Petroleum are qualified to join.

In 1934 when the seven-company agreement between the above six concerns and Mitsui Oil failed to crystallize Nippon Oil, Ogura Oil and Mitsubishi Oil entered into a tripartite agreement. In the new cartel these three leaders are planning to enlist the participation of Matsukata Oil and the two international firms which withdrew from the seven-company agreement last year. While the international companies as yet have not given any definite answer to the invitation of the domestic concerns, it is possible that they will come into the new cartel, as the demands they made were met, partially at least, in the present sales quota.

The new gasoline cartel outwardly is a six-company agreement, but it is observed that the three principal outsiders—Aikoku, Niitsu and Hayayama—recently clarified their attitude by expressing their intention of joining it. A few other domestic companies have shown signs of following suit. The new cartel, therefore, if established, will become the strongest gasoline cartel that has ever existed in this market, or possibly in any other. The Koyu Rengokai, or the Union of the Mineral Oil Companies, aiming at controlling mineral oil other than gasoline, was founded in December, 1934. It enlisted leading domestic oil manufacturers, such as Nippon, Mitsubishi, Ogura, Asahi, Toho, Aikoku, Yayakawa, Teikoku, Toyo, Kyushu and Nippon Motor Oil. The member companies recently held the first directors' meeting to decide upon the details of the agreement.

The primary objective of the union is to advance the market prices of various oil products. To do so, the companies concerned combined the sales quotas allotted to member companies by the Ministry for Commerce and Industry in order to determine whether total sales for the current year will exceed the domestic demand as estimated. Should there be any probability of an oversupply, they intend to make adequate reductions in shipments to balance supply and demand. Succeeding in this, they plan to raise the prices of their products. It is expected that upon the heels of higher gasoline, as recently decided upon, a rise in prices of other oil products will soon follow.

I. F. S. to Encourage Refining

(Continued from page 193)

door of the Corporation, who are accused in the first place of making the Soviet distributing agency a present of nearly £4,000, the difference between the actual contract price, and the alternative offer of the British companies.

Corporation spokesmen have pointed out that the R.O.P. price was for motor spirit exclusively, against the inclusion of part naptha in the "national" companies offer, but there is no real basis for this contention, since the Corporation's own transport department advised the inclusion of a proportion of naptha in the contract.

An aspect of the affair which has aroused most criticism is the fact that associates of the companies making the "national" group's tender, chiefly subsidiaries of Scottish Oils, Limited, employ 4,000 miners in the West Lothian shale-oil industry, and that the "combine" companies between them absorb a considerable volume of Scottish labour, including 800 employees in Glasgow itself. It has also been emphasised that the "national" concerns, which have held the Glasgow contract for a number of years, have given the Corporation a first-rate service, and have been recently helping out the Transport department with day-to-day supplies of motor fuel through their possession of wide supplies and a highly efficient distributive organisation.

When it is added that undertakings associated with Scottish Oils and Shell-Mex Limited are building seven tankers on the Clyde at the present time, thereby providing employment for 7,000 workers in the Glasgow district, the local annoyance at the placing of Glasgow's motor spirit contract abroad is easily understandable.

The question of this contract has since been discussed in the British House of Commons, but the government has no direct authority over the internal affairs of local councils who keep within the law.

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Difficulties Over £2,000,000 Law Deposit

LITIGATION in Mexico over the Amatlan claim has placed the Mexican Eagle Oil Company in a position which is officially described as "grave". This lawsuit was originally brought against the company by a local concern, the Compania Petrolera Commercial, which claimed 20,000,000 pesos in respect of the extraction of oil from Lot 113 Amatlan. The claim was allowed by the Third Civial Court, and Mexican Eagle has already lost an appeal to the Superior Court. On further appeal to the Supreme Court, it was ruled that Mexican Eagle should lodge cash security for the total amount of the claim plus interest, amounting in all to about £2,000,000, in a bank. This sum was duly lodged in the Midland Bank, London, but the Mexican authorities held that the deposit in a foreign bank does not comply with Mexican law. The company was thus faced with the necessity of depositing £2,000,000, a large proportion of its resources, in a Mexican bank, a step which is hardly encouraged by recent treatment of foreign capital in Mexico.

That a serious view was taken of the position is evident from the calling together of Mexican Eagle shareholders at a special meeting for discussion with representatives of the managers of the Company, the Bataafsche Petroleum Maatschappij. At the same time, Stock Exchange dealings in Mexican and Canadian Eagle shares were completely suspended. Action of this drastic kind, taken both by the Mexican Eagle managers and by the Stock Exchange at the mere prospect of lodging cash security in a foreign bank, exemplifies the loss of international confidence in the prospect of getting a square deal in some countries of the world. Security which oil and other industrial concerns previously enjoyed has, in fact, been weakened seriously within recent years by numerous oppressive acts, not only in Mexico, but in numerous other countries, which have added greatly to the inherently speculative character of oil production.

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Thames Haven Floats £1,333,333 Subsidiary

FORMING a £1,333,333 holding company to float off its shareholding in Compagnie Industrielle Maritime, London and Thames Haven Oil Wharves Limited has adopted an expedient which has been used in British company finance several times within recent years.

For some time the Thames Haven directors have been seeking the best method of dealing with the company's interest in the French undertaking, which has been successfully developing port facilities and an oil handling business at Le Havre. Issued capital of the Compagnie Industrielle Maritime is 400,000 shares of 500 francs each, of which Thames Haven recently held 285,687.

An English company, entitled C.I.M. Holdings Limited, has now been formed to acquire 200,000 shares from the Thames Haven holding. C.I.M. Holdings has a capital of £1,333,333 in 1,000,000 four percent cumulative preference and 333,-333 ordinary shares, all of £1 each. All the preference have been offered to existing shareholders in Thames Haven, which guarantees the dividend and subscribes for the whole of the new company's ordinary capital. As a result of the operation, the Thames Haven Company is being placed in possession of additional cash to the extent of approximately £950,000 net.

As a means of increasing Thames Haven's cash resources, which the company's annual accounts for 1934 show to be desirable, the formation of the holding company is a sound move. Compagnie Industrielle Maritime is a progressive concern, with considerable profit earning capacity now that its major development programme has been completed. Apart from the prospective dividends on its shares, on which the holding company's income will be based, Thames Haven's annual earnings provide first-class security for the guarantee it has given of the C.I.M. Holdings preference dividend.

Economic Significance of the 10,000-Foot Well

By Improvement in Equipment and Technique Drilling Engineers Have Mastered the Problems of Penetration to Extreme Depths — Limitations Are Economic Rather Than Mechanical.

By John F. Dodge

Professor of Petroleum Engineering
University of Southern California

THE history of the production branch of the petroleum industry has been one of continued striving for better equipment to find, develop and produce crude petroleum. This continued striving has been paralleled in the refining industry by a continual development of new processes and new products, resulting in a constant growth in efficiency and a steadily expanding use of petroleum by mankind.

Hobson A-2, the first 10,000 ft. well

From Col. Drake's 69-foot well to the 12,000-foot well of today the production industry's efforts have been directed principally toward the development of equipment and techniques that would enable the producer to go deeper and ever deeper for new sands as the increasing use of petroleum and the exhaustion of shallower sands made the deeper drilling necessary and financially attractive.

The problem of successful deep drilling is one of many angles but the principal factors to be considered fall largely into one of two classes: first, mechanical, and second, economic. From a mechanical standpoint, one may safely say today that oil company engineers and equipment manufacturers working together have designed and produced equipment and evolved techniques for its use that are far ahead of the corresponding production equipment and techniques. Until the production engineer catches up, the development engineer may rest upon his laurels.

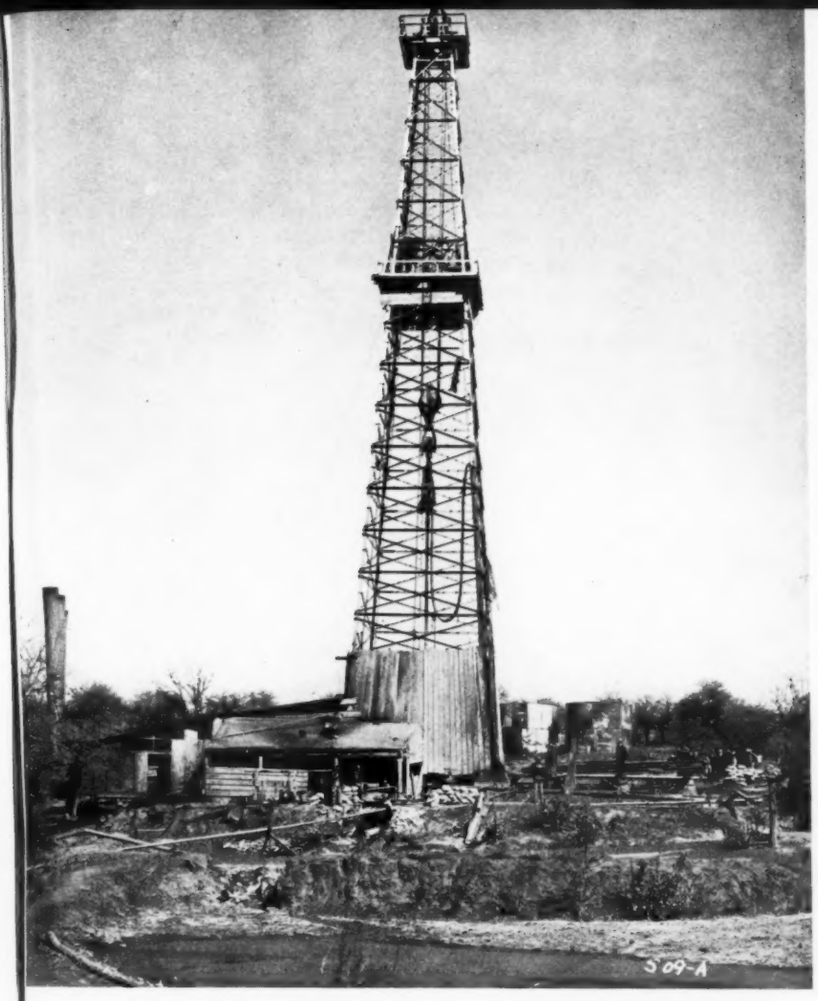
None of the present very deep wells has been productive in its extreme depths and opportunity therefore has not been given for the production engineer to try his hand at producing a 10,000-foot well. The difficulties encountered today, however, in operating wells economically below 8,000 feet once they have stopped flowing would seem to indicate rather definitely that present production methods and equipment will be quite inadequate for operating a 10,000-foot well in the same condition. At present one might say, therefore, that a deep well must justify itself economically upon the basis of its flowing life production alone.

What constitutes a deep well? In 1926 R. H. Garrison presented a paper upon THE DEEPEST WELL IN THE WORLD before the American Petroleum Institute in Los Angeles. The well in question was Miley Athens No. 6 in the Athens Rosecrans field in Los Angeles County, California, which had just been completed as a successful producer at a depth of 7,591 feet. As a part of his paper, Mr. Garrison included a list of all the deep wells known up to that time. Examination of this list discloses only eight wells deeper than 7,000 feet. Today, only eight short years later, we have whole fields, such as Kettleman Hills, where every well is deeper than the deep well of 1926 and we have at least twelve wells on the North American continent which are below 10,000 feet, with new records for penetration being established at short intervals.

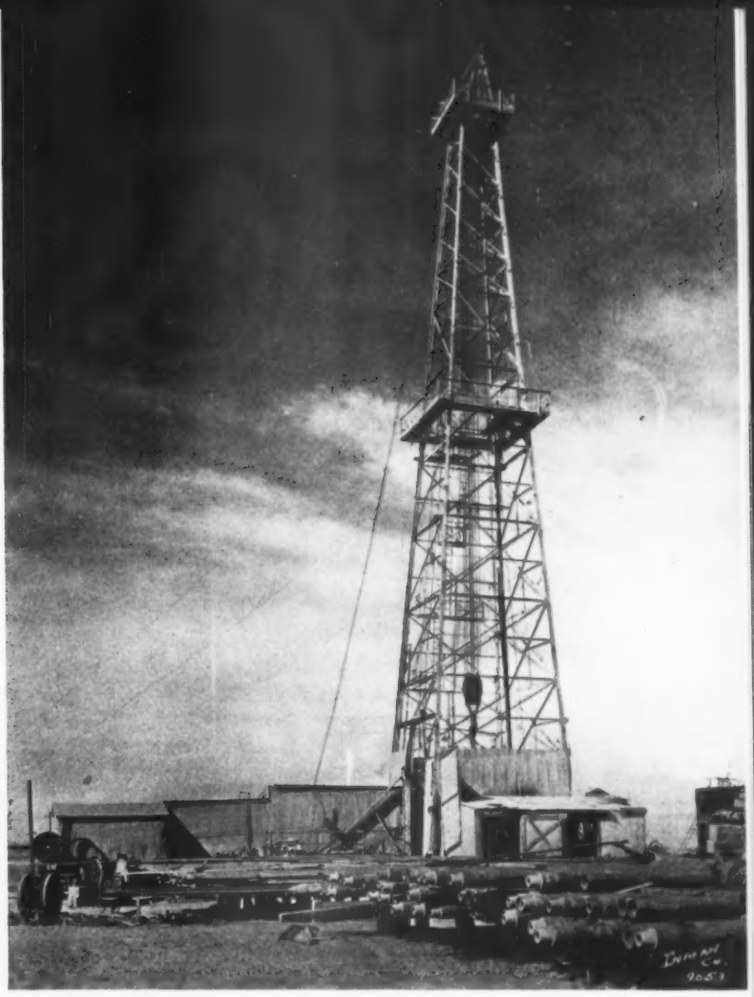
With the purpose of presenting as briefly as possible a résumé of current deep drilling practice and equipment in use, a table has been prepared directly following this article (1) in which will be found the available data on 13 representative wells which have passed the 10,000 foot mark. Examination of the salient facts discloses something approaching standard mechanical practice even in these new achievements and despite the wide geographical distribution of the wells.

Before turning to the economic factors it might be well to review briefly the changes in mechanical equipment which have facilitated deeper drilling, as suggested by an examination of the accompanying table.

The casing programs of these wells illustrate the great advances made in materials available to the development engineer within the past eight years or since the days of Miley Athens No. 6. Seamless casings of tensile and collapsing strength undreamed of then are available today and two grades beyond the "Grade D" in common use in present deep wells are available upon special order. The increased tensile strength together with improved collar or coupling design has made possible the safe handling even without float collars of strings far beyond the "pull out" limit of yesterday. New sizes are available with carefully designed clearances which make possible the completion of the well with a reasonably large bore without too large starting diameter. In the Kettleman Hills special flush joint strings have been used to minimize further the reduction in hole diameter made necessary by the setting of an additional string. In the same connection should be mentioned the perfection of the "full hole cementing devices" now in common use



A-Dah-Noe, Binger Caddo County, Oklahoma



Kenda 56-8-Q in Kettleman Hills, California

to permit the safe installation of combination strings of casing, where one string is made to serve the dual duty of water string and oil string as well.

Drill pipe has been improved metallurgically, the use of alloy steels and heat treatment now being common practice. Perhaps the greatest improvement in the drill pipe has been the development of the full hole tool joint which removes the constriction in the path of the drilling mud now present at each double, thus reducing the friction head and making possible higher mud circulation rate and lower pump pressures. The higher circulation rates have been found necessary to remove completely cuttings from the deep well, many cases of stuck drill pipe being clearly traceable to the failure to effect such removal, due either to the pump's inability to deliver sufficient volume of mud against the high back pressure or the actual failure of equipment under the terrific loads imposed upon it. Deep wells in California using the old tool joints have encountered much difficulty in the hydraulic abrasion of tool joints, both internally and externally and the new design which eliminates turbulence at the joint has eliminated this cause of drill pipe failure. In one California well the use of these new joints reduced pump pressures over 300 lbs. per square inch even while an increased circulation rate was being maintained.

Very little change has been necessary either in the design or handling of mud pumps to increase the depth attainable by the rotary rig. The same pump equipment used for 8,000 foot wells functions satisfactorily at 11,000 feet with minor changes in liner and valve design.

Similarly little change has been necessary in engine or draw work design to add 4,000 feet to the range of the rotary. Some of the deepest wells have been drilled with the older three speed draw works although the four speed equipment has been available for many years and adds considerable speed to the handling of drill pipe. Higher steam pressures and the use of superheaters are prevalent in the wells headed for the greater depth and in general more refinement in installation is observable, more attention being paid to efficiency in boiler setting and burner design and the insulation of steam lines since the savings to be effected are greater due to the greater length of time the boiler plant is to be used.

Some improvements have been necessary in travelling blocks and hook design, since the increased loads exceeded the safe working capacity of the older equipment. In some cases the hook has been eliminated and a clevis of new design substituted. The design of a hook for great loads has always been a troublesome problem due to the complicated stresses involved and the complete elimination of the hook seems desirable if another design can be found that will permit rapid changing of equipment on the blocks.

It has long been recognized that economical deep drilling could only be possible with bits that would give many hours of service before replacement as hole is only made while the bit is on bottom and with increasing depth, each round trip to change bits took a longer time and further reduced the efficiency of the entire operation. Little real change has been made in the design of bits but enormous strides have been made in their metallurgy. Heat treatment and the use of hard facing materials have increased many fold the footage made by each bit and with greater attention being paid to the proper load on the bit and to rotary table speed the percentage of time on bottom has been greatly increased in spite of the greater length of time necessary for each round trip to change bits.

Berry No. 1, General Petroleum Company's deep well in South Belridge field, California

One of the most difficult problems in deep drilling and one which is still but partially solved is that of the proper control of the characteristics of the drilling mud. Drilling mud has a number of functions, some relatively simple and easily performed by almost any mud and others less simple and involving characteristics that are almost directly contradictory for two given functions, as for example the ability to suspend cuttings in the hole during periods of interrupted circulation and yet to drop them quickly in the ditch once the mud reaches the surface. The control of the properties of the mud in the circulation system is receiving much attention at present and a great deal of careful research work is being done to determine just what are the desirable characteristics in a drilling fluid, how they may be attained and how maintained. Some of the simpler functions such as the hydrostatic control of high gas pressures and the sealing off of minor water sands have been met in a fairly satisfactory measure by the use of weight materials such as Baroid and the control of the colloidal properties of the mud by the addition of Aquagel or some other clay-like substance of high colloidal content.

Viscosity control under conditions of high pressure and temperature, particularly the latter, encountered in deep drilling and in the presence of the connate waters of varying chemical characteristics encountered is a problem not yet solved but one that must be solved before any degree of certainty can be given to the drilling operation. At least two of the deep wells in California have suffered long and very expensive fishing jobs occasioned by stuck drill pipe traceable directly to circulation difficulties.

The writer earlier expressed the opinion that drilling equipment and technique had advanced beyond corresponding production equipment and technique. Further consideration of this situation is necessary in order properly to appreciate the economic situation confronting the deep well.

The rod pump, used in production operations from the beginning of the industry, apparently has reached the limit of its applicability in the present deep producing wells in the Los Angeles Basin fields. Even with improved rod steel, heat treated, there is a definite practical limit to the depth at which a reciprocating pump can be operated by a string of rods from the surface and it is believed that the present 7,500 foot pumping well represents that limit. Similarly the straight gas lift, in the writer's opinion, has reached a depth limit in the same wells, due partly to mechanical difficulties, partly to economic considerations caused by high operating costs and partly to high back pressures on the formation difficult if not impossible to avoid in deep wells with low fluid levels. Intermittent gas lifts, electrically operated deep well pump and hydraulic plunger pumps have been and are being used in an attempt to recover at a profit the substantial amount of oil left in the formation at the end of the well's flowing life but to date little hope can be offered that the profit from such operations will form any appreciable addition to the profits derived from operations during the well's flowing period. Where fluid levels remain high for some time after the well stops flowing ordinary production methods may be employed but experience with Clark zone wells in the Santa Fe Springs field producing from a depth of 8,000 feet shows this transition period to be a short one.

One is, therefore, forced to the conclusion that until new equipment is developed or the present equipment greatly improved the operator will have to depend on recovering his investment from the profits made while the well is flowing. This at once limits economically possible deep drilling to fields where high pressure sands of considerable thickness exist from which wells of relatively long flowing life may be obtained.

Obviously, the most important single factor in the economic success of the deep well is the price of oil. Recent oil prices which are the result of the combination of a world depression with a flood of oil from uncontrolled flush fields do not justify prospecting at 10,000 foot depths. The oil producer, however, is always looking forward to that day in the future when the present flush fields will be exhausted and when higher prices will again prevail.

A great deal has been written regarding the world's future supply of oil and what the future trend of prices must be. For the purposes of this discussion it is only necessary to point out that there is a definite ceiling above which the price of crude oil cannot rise. The position of this ceiling is largely determined by the production cost of available substitutes, substitute motor fuels and lubricants being the two chief classes to be considered. As to sources of these substitutes we have lignite and oil shale beds to be mined and retorted, and hydrogenation and direct synthesis processes starting with coal as a raw material, even if we do not include inferior substitutes such as alcohol as a motor fuel and vegetable oils as sources of lubricants.

Immense quantities of heavy oil now burned as fuel in competition with coal would be replaced by coal and thus be available for cracking processes if the general level of oil prices be raised sufficiently. Just where this ceiling is located is a question involving too many factors for any one to hazard a guess, but a general rise to three times present crude prices would probably put an end to the use of fuel oil in heavy industry and a rise to five times present prices, say $3.00 per bbl. for heavy San Joaquin Valley crude or $5.00 per bbl. for Los Angeles basin crude would stimulate the production of petroleum substitutes to such an extent as to prevent further price increases.

So far as the writer is able to determine, few if any of the present 10,000-foot wells were completely designed to go to that depth and their costs do not fairly reflect the average cost of a group of wells planned to exploit a 10,000-foot sand. They are in general wells that were carried on and on in search of production, and eventually reached their record depths more or less accidentally, rather than as the result of a carefully planned program. Cost data are available however on many 8,000-foot wells and by extrapolation a fair estimate of the cost of drilling 10,000 feet as an every day procedure may be obtained.

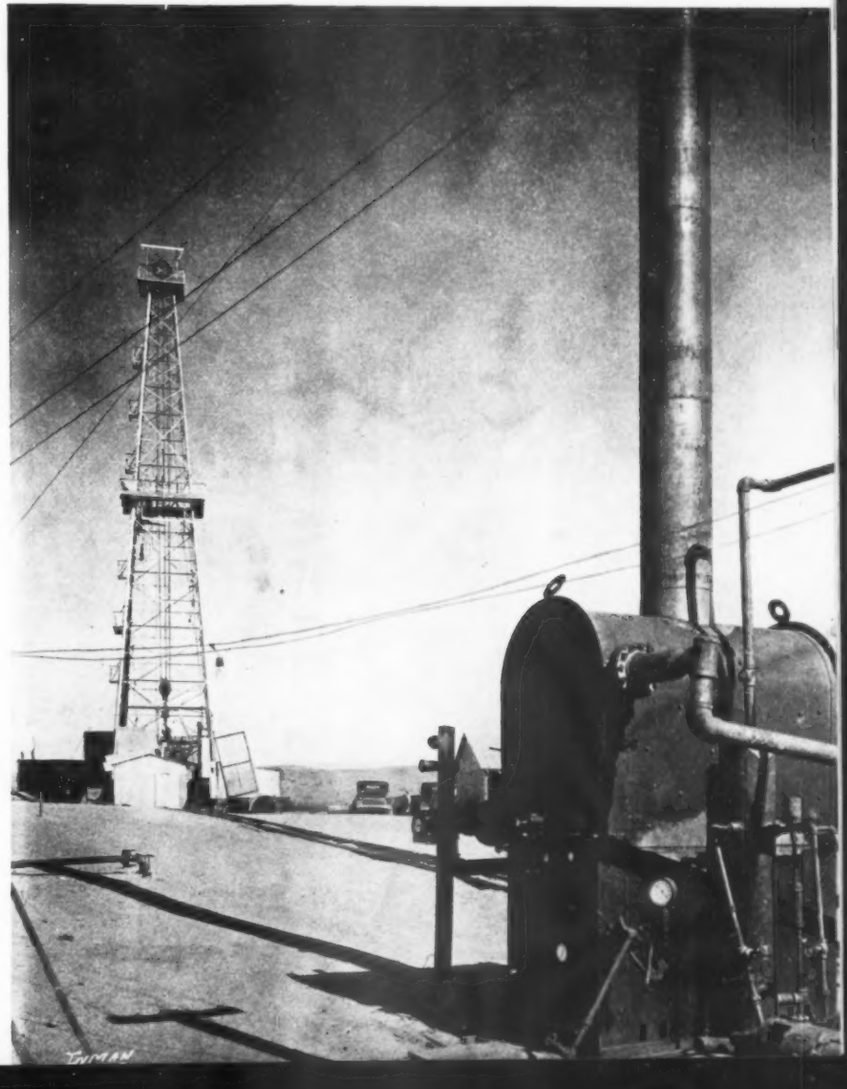
The writer's estimate for such a program would be a primary development cost of from $300,000 to $350,000 per well with supplementary expenditures for roads, buildings, pipe lines, tankage and other items ranging from 10 percent to 30 percent extra depending on terrain, location and other variable conditions. These figures do not include the cost of acquiring the lease but represent merely the cost of equipping the property with the necessary facilities for production and the drilling of the well itself.

With $1.00 oil, paying the usual royalties, and with only nominal cost for acquiring the lease a 10,000-foot well must show a reasonable assured recovery of 600,000 to 750,000 bbl. of oil during its flowing life, say during its first three years, to pay operating costs, royalty and return its development cost with 6 percent interest. Increasing oil prices will of course lessen the quantity of oil the well must make, but not in direct proportion since the margin between sales price and production cost will be greater and the royalty interest value also changes. With $2.00 oil, 350,000 bbl. ultimate flowing production might be expected to pay out and in like manner still smaller wells with higher oil prices. The hazard of a single mechanical failure or dry hole is of course great from the viewpoint of the sums involved but need be no greater proportionally than in shallower drilling in some of our more difficult fields today, as for example in Ventura Avenue field.

It is believed that it is safe to state that today the limiting factor in the exploitation of deep reserves is economic and not mechanical. With the development of better techniques in deep drilling which will come through more experience with 10,000 and 11,000-foot holes this situation will become more firmly established from year to year. However, if oil prices advance sufficiently we may eventually have a reversal of the situation and again at greater depths have the mechanical factors the deciding ones.

As to the increased reserves which may be made available by deeper drilling, the writer is qualified only to speak with reference to California fields. In the Los Angeles Basin fields, in the San Joaquin Valley and in certain of the coastal areas such as Ventura there is almost unlimited opportunity for drilling below 10,000 feet. So highly does the writer rate these possibilities that he believes it not at all fantastic to state that the reserves in sight may easily be doubled by drilling to 12,500 feet and that no unusual mechanical difficulties are to be expected that cannot be solved by skillful use of equipment and techniques now available.

While there are many areas in other parts of the North American continent where the present producing wells have penetrated all of the possible producing horizons and reached the basement complex, there still remain great geologic provinces which offer opportunities for deep drilling commensurate with those in California and a restoration at some future time of the oil prices of 1920 will no doubt see these opportunities realized.



Lillis-Welsh No. 1 at Kettleman Hills, California, drilled by Ed. McAdams.

Well	Chanslor-Canfield Midway Oil Co. Hobson 2 A	Western Gulf Oil Co. Bradley No. 1	Union Oil Company Lillis and Welsh No. 1	General Petroleum Co. Berry No. 1	Kettleman North Dome Association 56-8-Q	Marathon Oil Co. (Successor to Mid-Kansas Oil & Gas Co.) Culp No. 6
LOCATION	Ventura Co., Cal.	Santa Barbara Co., Cal.	Kettleman Hills, Cal.	Kern Co., Cal.	Kettleman Hills, Cal.	Cement, Okla.
DEPTH	10,030	10,296	10,944	11,377	10,154	10,079
RECORD	Plugged back to +7500	Unproductive	Redrilling	Good oil showings with heavy gas pressure 10,370 to 10,705′ and 11,200 to 11,377′	Plugged back, redrilling	Dry hole at depth. Plugged back to 10,100 ft. and producing about 75 bbl. daily
POWER	Oil Well Type "R" Hild electric drive 2 Westinghouse 25–65 H.P. motors	Oil Well Type "S" Electric Hild drive Gasoline engine standby 35–75 Westinghouse motors equipped with blowers for cooling	Steam, Ajax engine	Oil Well Type "R" Hild electric drive Gasoline engine standby 125 H.P. Waukesha Two Westinghouse 25–65 H.P. motors	Gardner-Denver 12 x 12 and 14 x 12 steam engine	4 Kewanee boilers 300 lb. pressure Ideal-Ajax, 12 x 12 twin cylinder engine
ROTARY TABLE	National Ideal	Ideal 22″ brake Oil Well 27-Model 3 rotary	Emsco	Emsco	Emsco 27½″ enclosed type H	Ideal, oil bath type
DRAW WORKS	National Ideal, roller bearing	Ideal No. 7½ R.B. type K Oil Well California Style 7″	Emsco	Emsco No. 7½ Parkersburg Hydromatic brake	Emsco H 46 Parkersburg Hydromatic brake	Ideal, jack-shaft
DERRICK	Emsco Steel, 122′	McClintic-Marshall Steel, 122′	Ideco, 136′ steel	Emsco, steel 122′	Emsco 136′ steel with tubular reenforcing	Parkersburg 122′ steel on concrete base
HOOK AND BLOCKS	Regan 72″ casing block Oil Well No. 90 swivel	9″ M.T. 5-sheave Regan Emsco B6 swivel Oil Well No. 90 swivel	Emsco swivel	Emsco swivel and crown block	9″ Regan hook 10″ Wilson connector 66″ Ideal 5-sheave traveling Emsco G 87 crown, Emsco swivel Oil Well No. 150A swivel	Regan 6-sheave rotary crown block and 5-sheave traveling block
WIRE LINE	1750′—1″	2500′—1⅛″		Broderick & Bascom 1″ line	2500′ x 1″ plow w/wire rope center 2500′ x 1″ Imp. plow w/hemp center	Roebling, 1350′–1⅛″
CASING PROGRAM	795′—18⅞″ O.D. stove pipe 4326′—11¾″—60 lb. Youngstown 6640′—8⅝″—36 lb. grade D, National Tube 7479′— 5¾″—22½ lb. American Seamless Liner set inside 5¾″ O.D. casing 900′ 4½″ National Tube 1730′ 4½″ Youngstown	853′—16″ OD 75 lb. Ger. T.C. 4706′—9″ OD 45 lb. National Seamless 5990′—5¾″ OD 22.5 lb. National A.P.I. Grade C Baker cement float shoes and collars	1275′—18⅝″ 84.50 lb. National Seamless slip joint 6710′—11¾″ 61 lb. Grade D J. and L. 9642′—7″—36 and 30 lb. Grade D, J. and L. Baker cement float shoes and collars	728′–20″ OD 106 lb. National slip joint 4500′–13⅜″OD 61 lb. Grade C, Youngstown 7745′–8⅝″ OD 36 lb. Grade C & D, Youngstown 9717′–6⅝″ OD 28 lb. Grade D, Youngstown 9616′–4¾″–16 lb. grade D flow string Youngstown 9623–11,377–4¾″ 16 lb. Doheny Stone flush liner Youngstown Baker cement float shoe	1200′–20″–104 lb. National, grade C 6847–13⅜″–61 lb. Spang and Youngstown. Lower 400′ of 68 lb. Standard. All grade D 8304′–9⅝″–47.6 lb. J. and L., grade D Baker cement float shoes and collars	64′–12½″ 50 lb. Lapweld 5515′–9″OD 40 lb. Grade D, Youngstown 9773′–6⅝″ OD 26.2 lb. Grade D, Youngstown seamless Baker side hole cement float shoe, Baker cement float collar
DRILL PIPE	10,030′—2⅞″ O.D. 10.40 lb. National Tube internal upset, grade D Baker drill pipe float	6″—25.2 lb. 4″—16.2 lb. 2⅞″—13.2 lb. tool joints	6710′ 6⅝″—25.20 lb. National grade D, Seamless 9638′—4½″—19.60 lb. J. and L. "Blue Ribbon" 10,944—3½″—13.30 lb. National "D" Seamless 4″ tool joints to 9936′	Youngstown 4″ to 9972′ Youngstown, 3″ to 11,377′ with 2000′ Hydril flush on bottom of string Baker drill pipe float, Bakwik type	4½″–19.2 lb. J. & L. grade D, A.P.I. top 2000′ 4½″–16.6 lb. Standard grade D, A.P.I. 5 9/16″ tool joints	5515′–6⅝″ OD, 25.20 lb. Grade D National internal upset 10,079′–4½″ OD, 16.60 lb. Grade D, National internal upset Baker drill pipe float
BITS AND CORING EQUIPMENT	Reed rock bits Globe-Smith drilling bits Globe core bits Allen and Oliver core drills Berry and Chicksan	Reed rock bits, Fishtails to 5340′ 4¾″ cone type and roller type rock bits at lower depths	Reed, Globe, Zublin, Hughes rock bits Fishtails to 6710′ Dean, Baker, Crum-Brainard, Catland Zublin bits sidetracking at 10,265′	Reed, Globe, Hughes 3-core, Zublin bits milling at 10,966′ Baker core barrel Dean core drill Hydril diamond	Reed rock bits and core barrel Hughes rock bits, Dean core drill and shoulder bits Zublin bits straightening and reaming at 10,154′ Globe Type J core bits	Reed and Hughes rock bits
DRILLING MUD AND SCREENS	Native mud with Baroid and Aquagel Lemco mud screen	Native mud	Coalinga native and colox weighting material Aquagel Lemco mud screen	Mojave mud with Baroid and Aquagel Link-Belt mud screen	Coalinga red mud. Colox and Baroid weight material. Aquagel Link-Belt mud screen	Baroid and Aquagel used to maintain weight 9½–10 lb.
SLUSH PUMPS	2 Gardner-Denver 6¾ x 14″ 3000 lb. type Westinghouse motors	Two 6¾ x 14″ Oil Well power pumps Westinghouse motors, 75 H.P.	Two Gardner-Denver 6¾ x 14″—1500 lb. type	Three Gardner-Denver 6¾ x 14″–3000 lb. type Westinghouse 25–65 H.P. motors	Two Gardner-Denver 7¾ x 20″–2000 lb. type, steam driven	Ideal 14½ x 7½ x 18″
MISCELLANEOUS EQUIPMENT	Kerotest high pressure valves Emsco rotary chain BJ elevators BJ tongs Shaffer cellar control gates	Westinghouse fan blowers Kerotest valves Baker hydraulic expansion wall scraper BJ elevators BJ tongs Martin-Decker weight indicator Halliburton measuring device Shaffer cellar control gates	Foster-Wheeler super heater Kerotest valves Sievers reamer for bit stabilization and reaming for casing program Baker hydraulic expansion wall scraper Globe-Smith underreamer BJ elevators BJ tongs Martin-Decker weight indicator, Vernier and mud pump gage Halliburton measuring device Shaffer cellar control gates	Goodrich rotary hose Kerotest valves BJ elevators BJ tongs Baldwin-Duckworth chain Sievers reamer Baker hydraulic expansion wall scraper Martin-Decker weight indicator Halliburton measuring device Shaffer cellar control gates	Halliburton measuring device Kerotest valves Sievers reamer Baker hydraulic expansion wall scraper Globe basket bit BJ elevators BJ tongs Martin-Decker Quintuplex Drilling control instrument Warren control head and Shaffer gates	Kerotest valves BJ elevators BJ tongs Martin-Decker weight indicator Halliburton measuring device, crooked hole tester, formation tester, and cementing service

THIRTEEN DEEPEST WELLS

Denver Producing and Refining Co. A-Dah-Noe No. 1	Superior Oil Producing Co. and Pure Oil Company Martinez No. 1	Amerada Petroleum Corp.—Rycade Oil Corp. Halff and Oppenheimer No. 2	Shell Petroleum Co. Jarnigin No. 1	Gulf Production Co. McElroy No. 103	Penn-Mex Fuel Co. Jardine No. 35	Creditul Minier, S.A.R. Chitorani No. 1
Caddo Co., Okla.	Acadia Parish, La.	Pearsall, South Texas	Roanoke, La.	Crane Co., Texas	Alamo, Vera Cruz, Mex.	Near Ploesti, Roumania
11,230	10,002	10,050	10,001	12,174 still drilling	10,585	11,167
Producing through 2½" tubing on gas lift 400–500 bbl. weekly	Showings	Plugged back, 3,950'	Blew out, fishing	Not completed	Completed Aug. 30, 1931 Unproductive	Unproductive
4–125 H.P. Donovan boilers Ajax duplex 12 x 12" engine	5–125 H.P. 350 lb. W.P. Broderick boilers equipped with Elesco superheaters Ideal-Ajax 14 x 14 Twin Cylinder Engine	3–125 H.P. boilers Ajax steam engine 12 x 12"	14 x 12 Gardner-Denver steam engine	4–125 H.P. 350 lb. W.P. Kewanee boilers Ideal-Ajax 12 x 12" twin cylinder engine	Six 50 H.P. Oil Well boilers One 11 x 11 Oil Well twin cylinder steam engine	Siemens-Schuckert 80 and 52 Kw. electric motors
Ideal	Ideal-27½", oil bath type	Ideal	Oilwell 26" Make-and-Break Model 32	Boykin 27" double deck Baash-Ross kelley joint B6 Emsco swivel	Ideal, 20 x 24"	Emsco "H", 27½" enclosed Emsco B6 swivel from 1635 to 2461 meters
Lucey 8" drum 7½" line	Ideal-Ajax–two 9" dia. shafts, Hydromatic brake	Ideal Parkersburg Hydromatic brake	Emsco 3-shaft Hydromatic brake	Emsco 3-shaft, 4-speed Parkersburg Hydromatic brake	National 5—C—3	Emsco, U-54 4-shaft, 8-speed
Parkersburg angle iron steel, 122' x 24'	McClintic-Marshall, 136'–30 x 30" steel	Parkersburg 122' old style with relegs	Emsco 136' steel	Parkersburg steel, 136'–26 x 26, on concrete foundation	Wood	Wood, 121'
Regan 6-sheave rotary crown block Baash-Ross traveling block	Ideal, 10' alloy steel hook; working load 300 tons Ideal, 6-sheave crown block, wt. 10,300 lbs. Ideal, 5-sheave, 42" traveling block	Ideal	Open bail hook, 300 ton, 5 sheave, 36" crown block	Byron-Jackson triplex hook, 300-ton capacity Emsco type B swivel	Ideal 90-ton swivel Ideal 5-sheave casing block and 6-sheave crown block	Emsco type "G" crown block Emsco 76" traveling block Emsco swivel
Union 1⅛"	Roebling 1¼" steel	Roebling 1⅛"	Broderick & Bascom 1⅛"	1⅛" Broderick-Bascom and Williamsport	1750'—1⅛"	Anglia and Ancora Romana
200'–15½" surface pipe 6238'–9" OD 40 lb. grade D J. and L. 9910'–6⅝" OD 26.2 lb. Grade D, National	1276'–13⅜" OD–54½ lb. Spang-Chalfant 9235'–7"–30.3 lb. Spang-Chalfant Baker cement float shoes and float collars	289'–13" OD–50 lb. Spang Chalfant 4952'–9⅝"–40 lb. Grade C, National 1003'–7"–24 lb. liner pulled after drilling to 6100'. Baker cement float shoes Baker cement float collars	7476'–9⅝" J. and L. 8743'–7" J. and L. Baker cement float shoes and float collars	762'–16" OD–70lb. National Lapweld 4015'–10¾" OD 46.20 lb. Grade D, National Seamless 10301'–7⅝" OD 34 lb. National, Grade D, special alloy seamless	190'—24" stove pipe 2236'—16" OD 75 lb. Spang Lapweld 2732'—13⅜" OD 61 lb. National Grade C Seamless 5200'—9⅝" OD 43.5 lb. Spang, Grade D Baker cement float shoes Baker cement float collars	4762'—38 lb. Mannesmann 3215'—36 lb. Mannesmann
6500–6⅝"–25.2 lb. National 6800'–4½" OD 16.6 lb. Spang-Chalfant 3200'–4½"–16.6 lb. National internal upset 11,230'–3½" OD–13.3 National, Grade D	5 9/16" OD, Grade D, Spang-Chalfant, 25.20 and 22.2 lb.	4½" grade D, Spang-Chalfant and Pittsburgh Steel 4" full hole tool joints	Hughes tool joints 6⅝" OD 25.2 lb. Grade D to 3,500 ft. 4½" OD 16.6 lb. to 8,760 ft. 3½" OD 13.3 lb. to 10,000 ft.	4300' 6⅝"–25.20 lb. Grade D, National internal upset 10,700'–4½"–16.6 lb. Grade D, National internal upset Reed 4½" A.P.I. full hole tool joints	2236'—6⅝" OD 25.20 National, Grade D, internal upset 5200'—6⅝" OD, Grade D, National external flush joint 10,585'—4½" OD 16 lb. Grade D National flush joint	Grade D, National 1635 meters "Youngstown" 6⅝" 31.9 lb. Grade D
Hughes rock and core bits and tool joints	Hughes four way drag, 3 core rock and full hole tool joints	Reed and Hughes rock bits	Reed core drills Zublin and Hughes core bits 251 bits and core heads used	Reed and Hughes rock bits and reamers Sievers 3-point reamer used in 19¾" hole A total of 858 bits used	Reed roller, fishtail Reed and Elliott core barrels	Emsco fishtail, Zublin Hughes automatic core
Native mud, Aquagel and Baroid		Formation mud except El Paso clay used last 300'	Baroid used to kill well	Aquagel	Native on upper part No mud in pressure drilling in line Aquagel Reverse circulation	Ponderosite for increasing weight Link-Belt mud screens
Johnson 14 x 7¾ x 18'	Ideal 14½ x 7½ x 18	Ideal	Two Wilson-Snyder No. 18 14 x 7¼ x 18	Wilson-Snyder 14 x 7¼ x 18" and Gardner-Denver 14½ x 7¼ x 20"	Two 12 x 6¾ x 14" Oil Well mud hog pumps	Gardner-Denver
9" OD x 6⅝ OD Hercules high-pressure, forged steel casinghead Martin-Decker weight indicator 13⅜ x 9" OD Hercules forged steel swedged nipple BJ elevators BJ tongs Halliburton measuring device, cementing service, multiple stage cementer, float collar, guide shoes, and formation tester	Martin-Decker Vernier weight indicator Kerotest valves BJ elevators BJ tongs Halliburton measuring device and cementing service 9⅝" drilling control hook-up with flanged mud cross, Shaffer gates and Warren head	Kerotest valves BJ elevators and tongs Martin-Decker weight indicator Halliburton measuring device, cementing service, formation tester, float collars and guide shoes	Kerotest valves Sievers reamer BJ elevators and tongs Martin-Decker weight indicator Halliburton measuring device and cementing service	Kerotest valves Martin-Decker weight control box BJ elevators BJ tongs Martin-Decker Quintuplex Halliburton measuring device, cementing service, float collars, guide shoes and formation tester	Kerotest valves on casing Regan control head Martin-Decker weight indicator Wilson elevator and tongs BJ elevators BJ tongs Halliburton measuring device	Emsco No. 3B and No. 4B chain Emsco automatic cathead Martin-Decker weight indicator BJ elevators BJ tongs

Problems in Exploitation of Deep Deposits

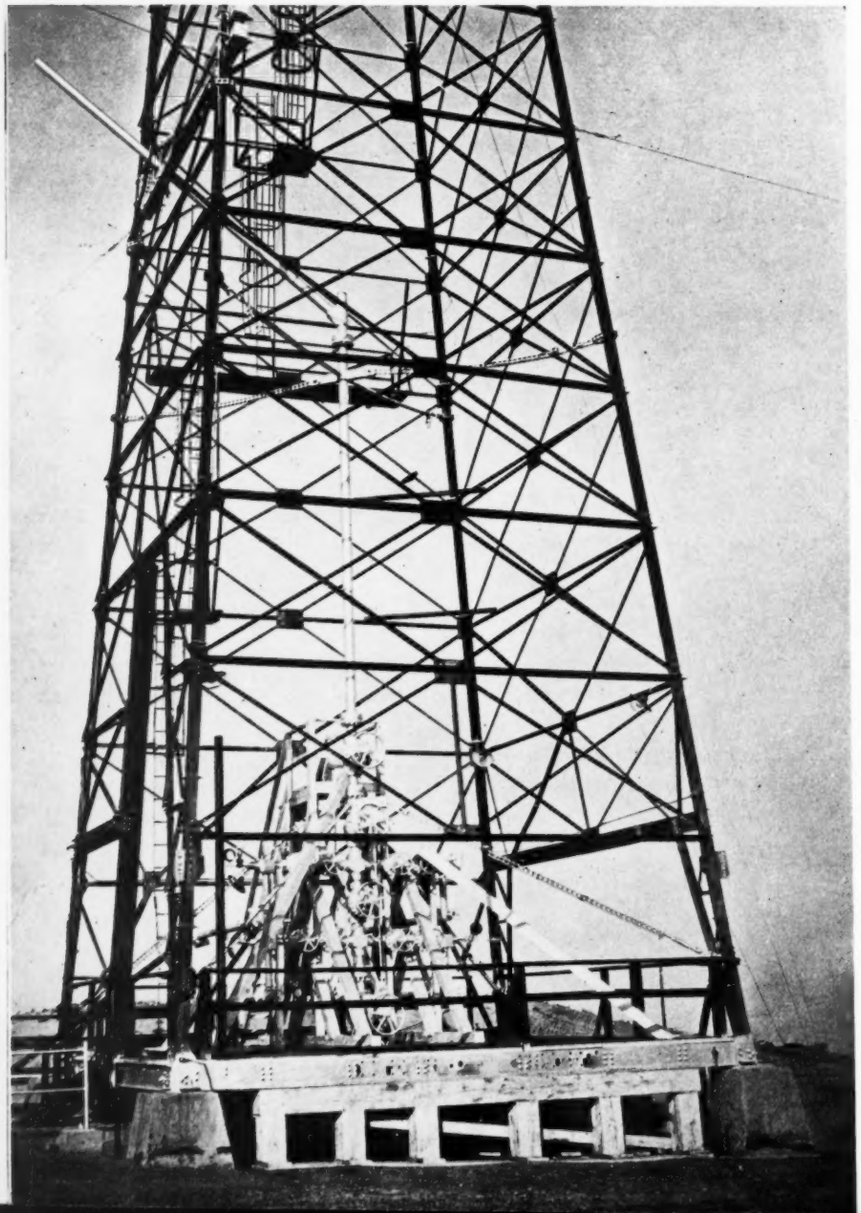
Engineering Technique as Well as Practical Experience is Required to Drill Below 10,000 Feet and Meet Successfully The Problems Set Forth in This Article.

By Lester C. Uren

Professor of Petroleum Engineering
University of California

SINCE the beginnings of the petroleum industry, producers have been reaching ever deeper for their supply of oil. In the early years following the discovery of oil in northern Pennsylvania, wells but a few hundred feet deep taxed the ingenuity of the pioneer well drillers to the utmost. Many months were spent in drilling wells that today would be regarded as mere "post holes." Two decades ago, four-thousand foot wells were regarded as "deep," but with the more extensive application of engineering in the oil producing industry during the last twenty years, depths previously undreamed of have been attained. With the drilling of the first ten thousand foot hole in 1931, some believed that the ultimate in depth for present-day equipment and methods had been reached, but the depth records continue to fall and one would be rash indeed who might venture to predict that the present depth record of 12,000 ft. will, ten years hence, seem unusual.

With the deeper drilling of recent years however, new problems have arisen: physical problems involving the development of stronger materials and heavier equipment necessary in conducting drilling and producing operations at these great depths; improved methods of production and well control necessary in contending with higher gas pressures and temperatures encountered at great depths and in securing drainage from the more thoroughly consolidated and lower permeability deep-seated reservoir rocks. Engineering ability of a high order has been responsible for the development of modern petroleum exploitation methods. The successful drilling and operation of these deep wells has had the attention of some of the best talent that the engineering profession has to offer. The problem of securing deep production has passed beyond the realm of the "practical" well driller and production man who formerly dominated the oil-producing industry, and has become a distinctly engineering problem. Only through continued application of engineering talent can we hope to secure production from still greater depths. The oil-producing industry must include in its rank and file a greater percentage of engineering personnel to deal successfully with the many technical problems presented.



Massive Christmas-tree assembly on a high pressure well in Kettleman Hills, California. Note the substantial bracing.

In this paper, a few of the physical problems with which the engineer has to deal in the exploitation of deep-seated oil deposits, are briefly discussed. Some of them relate to the drilling of deep wells, others attach to the production or operating phase. The industry is developing specialists within these two divisions of the oil-producing industry to cope more successfully with the problems presented. In the brief space here afforded, we can do little more than outline a few of the many problems with which the development and production engineers have to deal. In many cases, certain of these problems have engaged the full-time services of engineering and research personnel for many months or even years. Recent success in exploiting deep-seated oil deposits has not been entirely a matter of field development; research laboratories of oil companies, equipment manufacturers and educational institutions have contributed in no small degree.

Development problems have been largely concerned with the provision of materials capable of withstanding the great stresses imposed on drilling equipment, and with the design and development of devices for controlling more accurately drilling, casing and cementing operations at great depths. Problems connected with the circulating system used in connection with the rotary method of drilling have received no little attention. The influence of high pressure and temperature on the materials employed in deep drilling is also a matter of interest and importance.

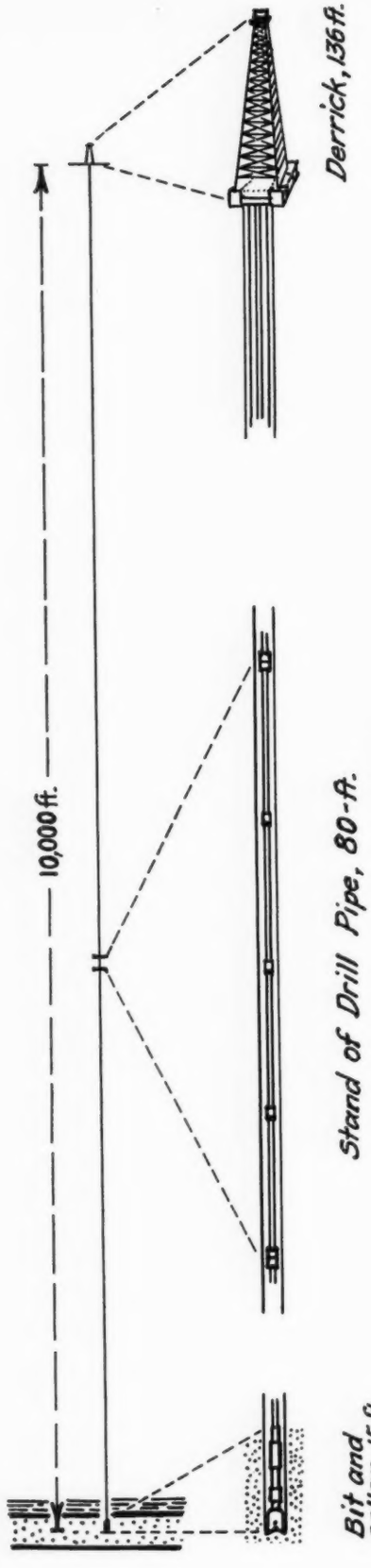
When one considers the mechanics of supporting and revolving a drilling tool on the bottom of a well, perhaps two miles below the point of support and control at the surface, and of so regulating the pressure on the drilling bit as to assure satisfactory progress, yet avoid breakage of the tool or its supporting drill pipe and prevent deflection of the hole from the vertical, it is apparent that some difficult physical and mechanical problems are involved. A ten-thousand foot string of 4½"-16.6 lb. drill pipe weighs eighty-three tons. It has walls only 0.337 in. thick, and if 20 ft. lengths are used, there would be 500 couplings and tool-joints or a total of 1,125 threaded joints. The duty is severe and the material and workmanship must be of the best. Steel having a tensile strength of 95,000 pounds or more per square inch must be used. A sketch is presented showing how such a column of drill pipe would appear if we could see it in the well suspended from the surface. It is impossible on the scale of this drawing to represent the proper diameter of the column of drill pipe in terms of its length, the line representing the diameter of the pipe in the sketch, being perhaps twenty times as wide as it should be.

Let us now picture how this tubular thread of steel, 30,000 times as long as its diameter, behaves in service. Though made of heavy, thick-walled pipe, the column as a whole—because of its great length—is very flexible. Excavation of the well is accomplished fundamentally, by the action of gravity. The weight of the drill pipe, bearing on the bit, causes it to penetrate the rocky material in the bottom of the hole, while turning the bit by rotating the pipe at the surface, enables it to break free, thus chipping and abrading the rock. In this process of rotating the drill pipe, we develop great torsional stress in the metal and many degrees of torsional deflection are imposed on the pipe between the rotary table at the surface and the drilling bit on the bottom of the well. The pressure on the bit must be carefully controlled, for if excessive, the bit will embed itself in the formation to such an extent that it cannot break free and breakage of the drill pipe or bit may result. Bit pressure must be controlled by supporting a large part of the weight of the pipe at the surface. Thus, if 12,500 pounds is the maximum pressure that may be imposed on the bit, 153,500 pounds or 92.5 percent of the weight of the column of drill pipe must be supported from the derrick crown. A nice adjustment and control of the surface equipment is necessary to allow just the proper amount of pressure to bear on the bit, maintaining its cutting action unimpaired, yet without subjecting the drill pipe to the hazard of a "twist-off." Necessity for proper control of bit pressure has been the inspiration for development of weight indicators and drilling controls of various types that have constituted major improvements in rotary drilling equipment during recent years.

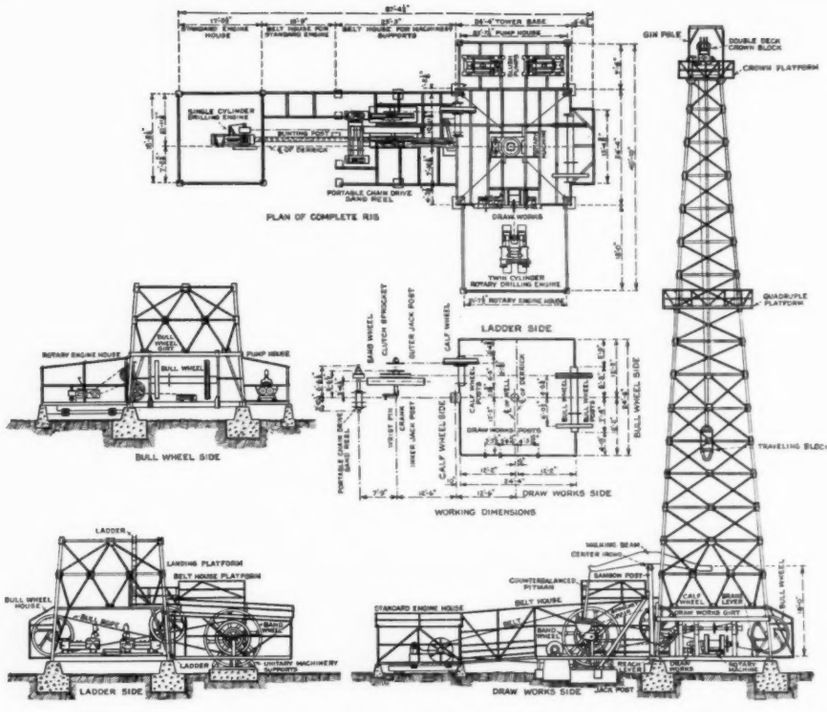
The upper part of the column of drill pipe is under tension, while the lower part is under compression and behaves as a distorted column. Under compressive stress, the lower part of the drill pipe is thus deflected to develop pressure contact with the walls of the well, probably assuming a corkscrew-like position in the hole for hundreds of feet above the bit. This flexible "corkscrew" is revolved with rapid variation in stress as the bit alternately digs into the formation and breaks free. There is doubtless considerable "whipping" of the pipe from side to side in the hole. Its eccentric motion is complicated by the vertical movement of the helical segments as the bit pressure and torsional and bending stresses vary within wide limits. The drill pipe is deflected into any cavities that may form in the walls of the well, occasioning severe bending stresses that are thought to be the principal cause of "twist-offs." The development of material and the manufacture of pipe that will successfully withstand such severe and complex stresses has been one of the notable contributions of steel manufacturers to the science of deep well drilling.

Oil wells are usually intended to be vertical or as nearly so as possible, but excessive bit pressure, formation of cavities in the walls, or steep-dipping beds of variable hardness, may cause the bit to be deflected so that the hole departs from the vertical. Unless care is taken to prevent, deep wells may become exceedingly crooked and the bottom may be hundreds of feet out of alignment with the top. A crooked hole may trespass on a neighbor's property so that the owner of the well becomes legally liable for damages. Such holes are productive of misleading stratigraphic information and are

Steel derrick of unusual height for deep drilling in Ventura field, California.



Sketch illustrating great length of column of drill pipe in comparison with its diameter and height of derrick.



Plans and elevations of a steel combination rig and derrick for deep drilling published by courtesy of Emsco Derrick and Equipment company.

costly to maintain and operate during the subsequent period of production. Well surveying instruments perfected during the last decade, have given the driller a means of determining when his well begins to depart from the vertical, and a whip-stock may be set in the hole to correct the difficulty. As a result of this development, deep wells may now be drilled with reasonable certainty that they will remain straight and vertical.

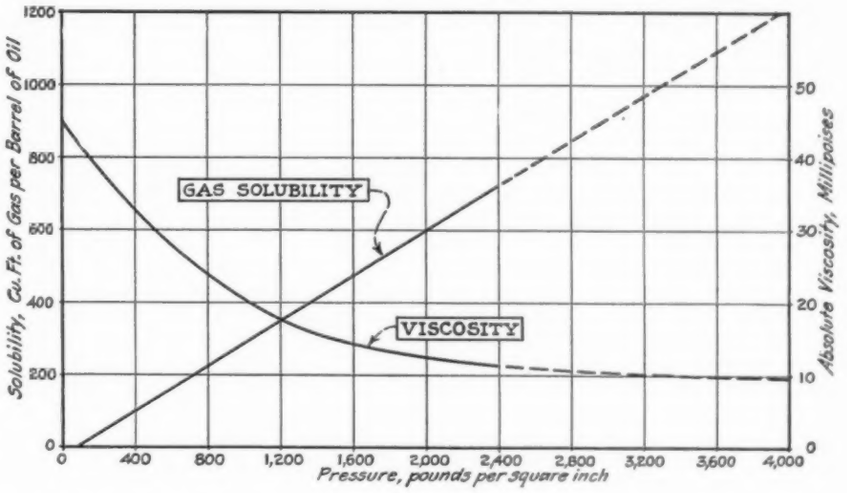
Out of this improved technic of well surveying and straight-hole drilling there has recently developed the comparatively new art of directional drilling, with the aid of which wells may be purposely deflected to reach an objective some distance away laterally from the site on which the derrick is located. It has thus become possible to tap deep-seated off-shore deposits along the Pacific Coast of southern California, with wells drilled from derricks situated on shore. By similar methods, three or more deflected wells may be drilled from one location, each to produce from a different area within the oil-producing formation.

The mud fluid used in rotary drilling has a number of important functions to perform and much of the success that has attended deep drilling operations in recent years has been a result of better understanding of the properties of clay fluids and improved methods of controlling these properties in the routine of drilling. Finely ground heavy minerals, such as barite and hematite, add density to the fluid, assisting in off-setting high gas pressures and preventing destructive "blow-outs." Highly colloidal clay, such as Bentonite, especially processed and added to ordinary mud fluids, improves their wall-building and lubricating properties and promotes gelling of the fluid when drilling is interrupted, thus preventing settling of drill cuttings and "freezing" of the drill pipe and bit in the hole. The viscosity of the drilling fluid is important in determining the pump pressure necessary to maintain circulation and the lifting capacity of the fluid for drill cuttings. Chemical treatment of drilling fluids is occasionally resorted to as a means of modifying the normal viscosity. At times the driller regulates the properties of the circulating fluid to promote deposition of clay in the wall rocks, thus sealing off porous horizons that may admit high pressure water or gas to the well or permit drainage of fluid from the well. At other times, as in drilling through an oil-producing forma-

tion, it is generally the desire to avoid this sealing effect. Oil sands are occasionally partially sealed off from the wells by mud deposition so that they do not develop the maximum production of which they are capable. Apparently the high subterranean temperatures encountered in deep well drilling are partly responsible for this undesirable action of the drilling fluid. The temperature increases rather uniformly with depth, a gradient of 1 deg. F. for each 50-ft. of depth being usual in some fields. Thus, at depths of 10,000 ft. or more, we may expect temperatures well above the normal boiling point of water. However, the temperature of the fluid would not be so high because of the cooling effect of the circulating fluid on the wall rocks, and even if such temperatures were developed, the fluid would not boil because of the high hydrostatic pressure existing in the well at such depths.

The physical problem of maintaining a sufficient ascending velocity in the drilling fluid in a deep well-drilling operation, to bring the drill cuttings to the surface, necessitates the use of large capacity, high pressure pumps. The problem is better appreciated when we remember that in a 10,000-ft. well, the viscous drilling fluid must be forced through nearly four miles of openings of restricted and variable cross-section and must furnish sufficient energy not only to overcome the resistance offered, but also to lift the drill cuttings to the surface. For every foot of hole 6 in. in diameter drilled in average sedimentary rocks at a depth of 10,000 feet, the fluid must theoretically expend 335,000 foot-pounds of energy in lifting the drill cuttings to the surface. Considering slippage or sinking of the solid material through the fluid on its way out and general inefficiency of application of the energy in this method of elevation, considerably more energy than this must actually be expended. The pump pressure necessary to maintain proper circulation can be reduced somewhat by use of "full-hole" tool joints which present no constrictions on the inside of the column of drill pipe, and by stream-lining their exterior or using flush joints so that they offer as little resistance as possible to the ascending fluid.

Some of the most difficult problems encountered in deep drilling operations are experienced in casing the wells. The long columns of heavy casing represent the greatest loads that must be handled by the surface equipment and difficult problems are presented in the design of the casing strings and in securing material of sufficient strength to withstand the great stresses imposed. Casing cost represents a large part of the total cost of drilling a deep well and important economies can be realized by intelligent selection of weights and sizes of individual strings.

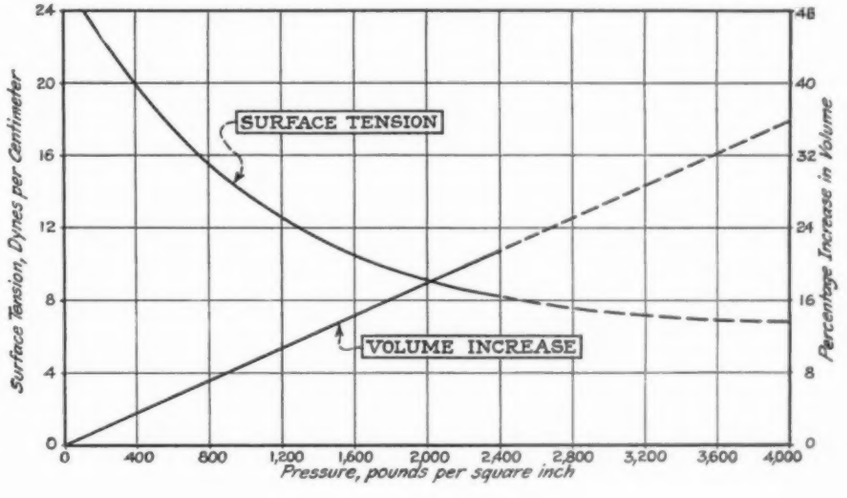


Graph showing increased solubility of gas in petroleum with pressure and resulting decrease in viscosity.

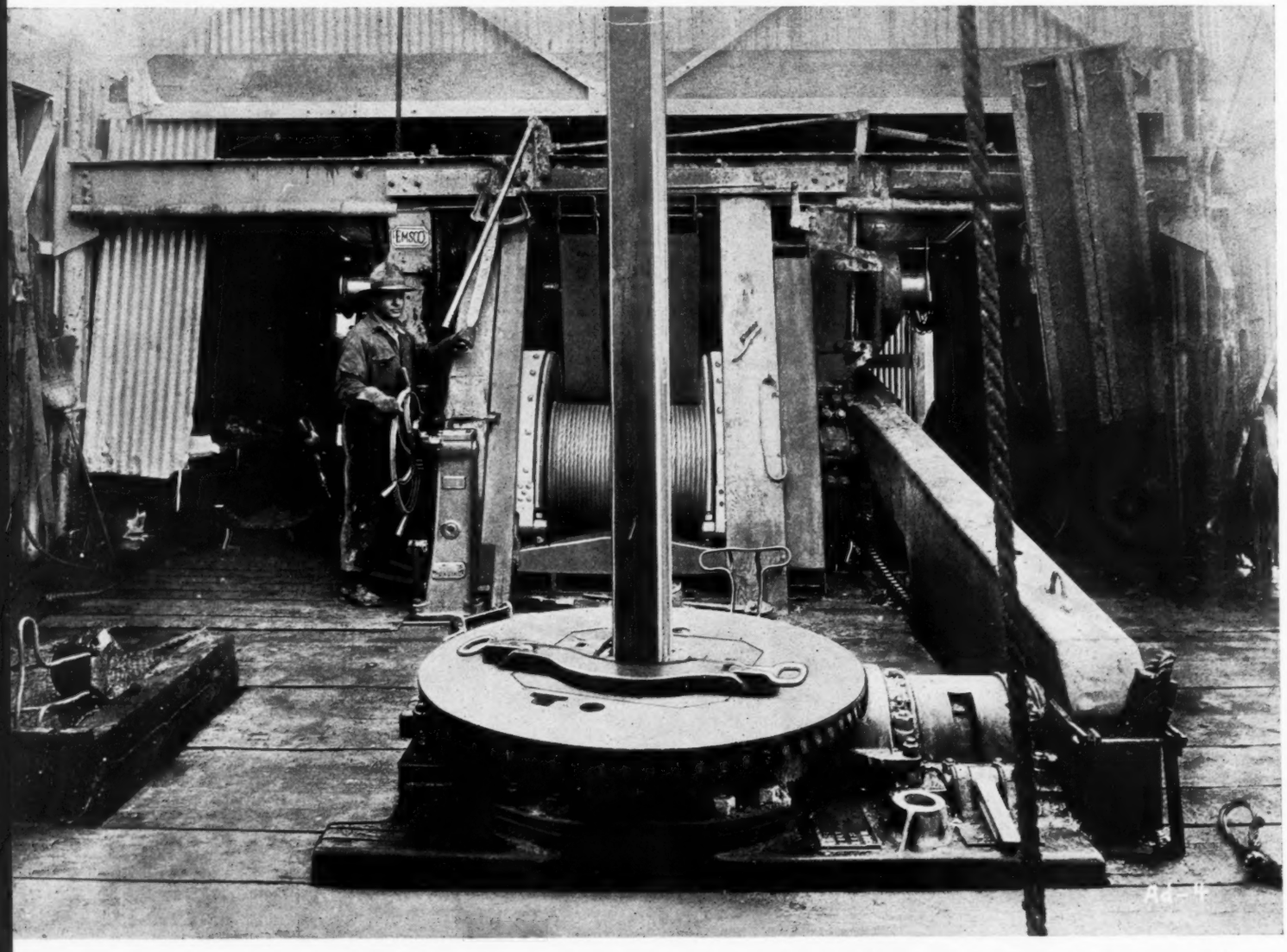
A column of casing in a deep well may be subjected to a variety of different stresses. Casing may fail under tension developed by its own weight while suspended from surface supports, or by threaded joints pulling out of the collars under tensional strain. Casing may collapse under the influence of high hydrostatic pressure or earth pressure applied externally, or it may fail under the influence of high bursting pressure developed within. When lowered into a crooked hole, pipe is subjected to severe bending stresses and when permitted to rest on the bottom of the hole it may fail by buckling under column loading. To contend successfully with the severe and variable character of the stresses imposed, casings in deep wells must be thick-walled and of high tensile strength material. A.P.I. Grade "D" casing or special alloy-steel casings, developing a minimum tensile strength of 95,000 pounds or more per square inch must generally be used. Special care is given to the design of joints to prevent failure by shearing of threads or tensional failure due to weakening of the metal by cutting threads. For conserving working space in deep wells of small diameter, flush-jointed casings of special design are now available.

A long column of heavy casing may weigh as much as 150 tons and since this great weight must be suspended from the casing line, blocks and elevators, they must be of substantial construction and

Graph showing variation in surface tension and volume of petroleum due to presence of dissolved gas at different saturation pressures.

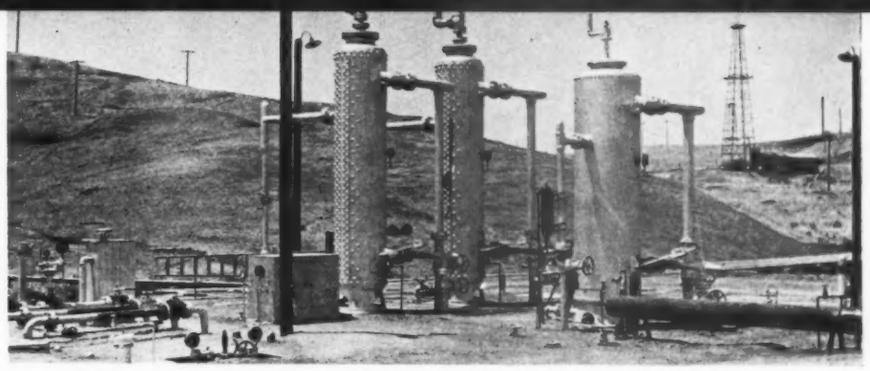


the derrick which supports both the casing and the hoisting gear will be severely stressed. Often long, heavy columns of casing are "floated" into wells by closing the lower end and taking advantage of the buoyant force of the well fluid in relieving to some extent, the strain on the surface equipment. Most of the weight of the long columns of casing must be permanently supported at the surface, for if the full weight is permitted to rest on the bottom of the hole, the pipe will fail by column action. Perhaps the most likely cause of casing failure in deep wells is that of collapse due to excessive external hydrostatic pressure. For example, in floating a long column of casing into a well filled with heavy mud fluid, high collapsing pressures may be developed. Or, if a column of casing is cemented in a well at its lower end and then bailed dry inside, the column of fluid left behind the pipe, extending perhaps to the surface, may create an excessive collapsing pressure. A column of average drilling fluid 10,000 feet deep develops a collapsing pressure of 5,000 pounds per square inch, a stress which only the heaviest of small diameter casings could sustain.



Heavy and powerful rotary drilling equipment suitable for deep drilling. ***(Courtesy Emsco Derrick and Equipment Co.)***

The cementing of casings in deep wells to exclude "top waters" from the oil reservoir rock, presents some interesting and difficult physical problems. Methods of cementing involve pumping the fluid cement slurry down through the casing from the surface, under the casing shoe or through perforations in the wall of the casing to a position outside of the pipe between it and the wall of the well. There the cement comes to rest while it sets and hardens. Large amounts of cement are frequently used: from 100 to 300 sacks or 5 to 15 tons are not unusual in cementing one string of small diameter pipe and larger amounts up to as much as 2,000 sacks for large diameter casings. Mixing all of this cement with water, forcing it under high pressure through thousands of feet of pipe into a space prepared to receive it a mile or two below the surface, within one hour, or before it takes its initial set, is an engineering achievement possible only by perfection of equipment and methods. Misplacing the



Stage-tapping installation for a high-pressure flowing well, Kettleman Hills field, California.

cement plug by only a few feet will sometimes result in failure to exclude water properly.

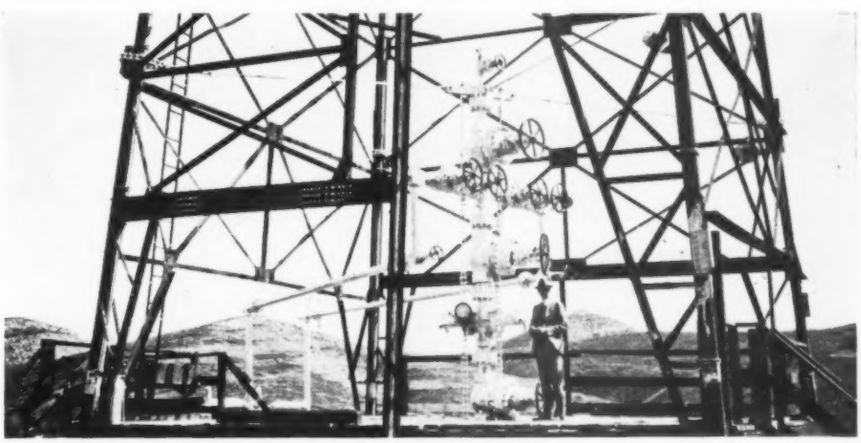
To meet requirements successfully, the cement used must possess dependable setting qualities and develop satisfactory final density and strength. Excessive dilution with water in mixing, or with mud or oil during the process of placement in the well, may result in failure of the cement to set or harden. Contamination with saline waters in the well may alter its setting properties. Gas blowing through the cement plug during the setting period may leave it porous or may leave channels through which water will later pass. High sub-surface temperatures common in very deep wells, may so shorten the normal period of initial setting that it is difficult or impossible to get the cement in place in the well before the initial set occurs. This difficulty can be met either by pre-cooling or by coarser grinding of the cement; also, by use of chemical retarding agents which prolong the period of initial set. To shorten the period of hardening, calcium chloride or other accelerators are usually added to oil well cements. Pressure, which increases with depth, increases the strength and density of cement and has but little effect on the setting properties.

Drilling to great depths requires the heaviest and most powerful of surface equipment, for the loads increase more or less directly with depth. Modern deep drilling rotary equipment differs not so much in form and design from the earlier equipment used in shallow drilling, as in size and weight. (See sketch.) Derricks are higher and of greater strength and are erected on more substantial and rigid foundations. (See p. 209.) Steel derricks, 136 ft. high and 26 ft. square at the base, designed for loads up to 500 tons, are preferred for deep drilling, and foundations are of heavy reinforced concrete. Double-deck crown blocks with large diameter manganese steel sheaves weigh as much as 6,300 pounds. The plow steel hoisting cable, 1 in. or 1⅛ in. in diameter, supports a massive five or six-sheave traveling block and hook designed for safe working loads as great as 300 tons. The swivel, weighing upwards of a ton, is capable of supporting a drill-pipe load as great as 300,000 lb. The rotary table, having a 27½ in. opening through it, may weigh as much as 10,000 lb. The draw works, of three-shaft, four-speed type, weighs about 20,000 lb. (See diagram.) Slush pumps of duplex, double-acting type, two or three in number, must be of large capacity and designed for high pressures. Steam cylinders 14½ in. in diameter, water cylinders 7¼ in. and a stroke of 20 in. are appropriate. They are designed for operating pressures as high as 3,000 lb. per sq. in. and weigh as much as 15,500 lb. Delivery capacities range up to 630 gallons per minute. The power equipment must be capable of providing continuously about 400 h.p. with some stand-by capacity. Steam power is still preferred by most drillers, but electric motors or Diesel engines can be used. Horizontal, twin-cylinder steam engines, 12 x 12 in. capable of delivering about 275 h.p. have been widely used for driving the draw works and rotary table, though some deep-drilling rigs have recently been equipped with three clyinder vertical engines developing about 320 h.p. Steam-driven pumps require from 90 to 150 h.p. Five 85 h.p. or four 100 h.p. boilers capable of developing and maintaining 200 lb. steam pressure will be desirable. If electric power is used, a 250 h.p. motor on the draw works is capable of drilling to 10,000 ft., or two motors of 150 h.p. each, geared to a twin-motor reduction gear. A 150 h.p. motor is sufficient for operating the pumps, utilizing an intermediate counter-shaft or reduction-gear unit. A pair of vibrating screens for desanding the drilling fluid are a desirable addition to the usual rotary drilling equipment. Most California operators prefer the combination rig for deep drilling operations, though the standard end of the rig may only be used as stand-by equipment in supplementing the rotary equipment for special purposes, as in running casing, fishing, bailing, etc. Six-inch rig irons are used.

Having discussed a few of the problems that are involved in the drilling of deep wells, it may next be of interest to consider briefly certain difficulties encountered in operating them after they have been completed and placed on production. In securing production from deep wells, we must be particularly concerned with the effects of high pressure and temperature conditions existing within the reservoir rocks and with the problems of lifting the oil through the well from such great depths.

Physical conditions within deep seated reservoir rocks differ markedly from those characteristic of shallow depths and necessitate the use of heavier control equipment on the casing heads, lead lines and traps than are normally necessary. The pressure of gas associated with petroleum increases directly with depth below the prevailing water table in the locality, initial gas pressures of 4,000 lb. per sq. in. or more being theoretically possible in oil deposits at depths of 10,000 ft. When the well is completed and equipped for production, this tremendous pressure may be brought to bear directly on the casing head fittings and connections. Four thousand pounds per square inch pressure imposed on an 8⅝ in. casing head, develops a lifting force of about 190,000 lb. Hence, casing heads must be securely anchored. As previously explained, deep-seated reservoir temperatures are high: probably well above the normal boiling point of water. Because of the high temperature and despite the high pressure, some of the low-boiling hydrocarbons that appear on the surface in the liquid phase, exist in the reservoir rock in the form of vapor. This condition is also promoted by partial pressure effects in the presence of a great excess of methane. For example, some of the early wells drilled in the gas-cap area of the Kettleman Hills North Dome field of California, produced several thousand barrels per day of a

Christmas-tree assembly on a high-pressure flowing well in the Kettleman Hills field.



transparent, almost colorless oil of 61 deg. A.P.I. gravity, with gas-oil ratios of from 20,000 to 30,000 cu. ft. per barrel. The reservoir conditions indicate that this "oil" existed in the reservoir rock as a vapor, though with the reservoir pressure of about 2,500 pounds per sq. in., this vapor must have had a density approaching that of the same substance in liquid form.

At the high pressures prevailing in deep-seated reservoir rocks, the oil is capable of retaining very large amounts of gas in solution, resulting in an oil viscosity and surface tension considerably lower than those characteristic of the oil at the surface. (See charts.) Under a pressure of 4,000 lb. per sq. in., at which pressure we might expect to find the gas in a reservoir rock 10,000 ft. below the surface, some oils would be capable of retaining as much as 1,200 cu. ft. of gas per barrel in solution. This great volume of gas would necessarily be released as the pressure is reduced during flow through the well and into the surface traps, gathering and storage facilities. On release of gas from solution with reduction of pressure, the oil undergoes considerable loss in volume, the volume at the surface being in some cases only 70 or 80 percent that in the reservoir rock.

From the foregoing it will be seen that in the production of oil and gas from deep-seated reservoirs, we must deal with the changing phase properties of an intricate mixture of hydrocarbon liquids, vapors and gases, and the presence of water in the reservoir rock with the oil and gas may add still another complexity. Computations of surface volumes from reservoir conditions are made difficult by the failure of the gas laws to apply with uniform accuracy at high reservoir pressures and temperatures.

Deep-seated reservoir rocks are likely to be more thoroughly consolidated than shallow sedimentary deposits. That is, they are usually harder and have lower porosity and permeability. The harder reservoir rocks are more difficult to penetrate with the drill, but once drilled, require less casing and do not cave or disintegrate under the influence of gas and oil flow. There is less trouble due to the presence of "float" sand in the oil produced. Low porosity means lower storage capacity, hence a smaller total quantity of oil available to the wells. This common disadvantage of deep-seated, low-porosity rocks is at least partially offset however, by the greater quantity of gas energy available, leading to a larger initial rate of production and a higher percentage recovery than is obtainable from shallow, low-pressure deposits of comparable permeability. Because of the higher reservoir pressures characteristic of deep-seated deposits, wells may be more widely spaced for the same drainage effect. Oils produced from deep reservoir rocks are likely to be of higher A.P.I. gravity than other oils produced from shallow depths in the same locality, and hence of greater value.

Because of the high pressure and large volume of the gas associated with oil produced from deep-seated reservoir rocks, the well-head control facilities must usually be heavy and substantial. "Christmas-tree" and lead-line valves and fittings, of cast steel tested to 6,000 lb. pressure, afford a margin of security that is none too great. The photographs reproduced on preceding pages show Christmas-tree installations in the Kettleman Hills field of California that are suggestive of what would be necessary for use under the high-pressure conditions that would normally be expected in 10,000 ft. territory. Stage-trapping of the gas from the oil is usual under high well-head pressures. Two or three stages of pressure reduction with the high-pressure traps designed for 500 lb. working pressure, would be usual.

Fortunately, because of the relatively large volume of high-pressure gas that is usually associated with the oil in deep-seated reservoir rocks, deep wells tend to flow a greater percentage of their production than wells producing from shallow depths. When the gas pressure becomes depleted in the deeper reservoir rocks, it is a matter of considerable uncertainty as to how the remaining oil will be brought to the surface. The producer welcomes the flowing well and strives to keep it flowing as long as possible, because it brings him low-cost and therefore highly profitable production. Little does he count the cost in reduced ultimate recovery that results through using formational energy to lift the oil when it might be conserved for the more important duty of forcing additional oil out of the reservoir into the well by lifting the oil in the well with artificially developed energy.

A barrel of oil lifted from a depth of 10,000 ft. would require about 3,100,000 foot-pounds of work. If there were no frictional or other losses, a thousand barrel well producing from this depth would require the continuous expenditure of about 65 h.p. Actually however, because of slippage of gas through the oil and frictional resistance of the rapidly flowing oil and gas through the well tubing, the usual efficiency is low. If the efficiency were 20 percent—a not unusual value for deep-well conditions—the actual energy expenditure would be 325 h.p.; almost enough power to operate continuously the rig that originally drilled the well. Much of this energy can be conserved and made to do useful work in bringing additional oil from the reservoir rock into the well, by injecting high-pressure gas into the annular space between the well casing and tubing at the casing head. This is the so-called "gas-lift" method of well operation. The cost of compressing the gas to the necessary injection pressure is more than off-set by the additional ultimate recovery secured.

Gas-lifting can only be continued as long as the back-pressure applied against the productive formation by the injected gas is less than the formation pressure. When the formation pressure declines to a point that precludes further use of the gas-lift method, we must resort to other methods of lifting. We have at our disposal the bailing and swabbing methods, which are primitive and costly, and mechanical pumps of different types. Oil producers up to the present time, have made wide use of rod-operated plunger pumps. Limited use has also been made of multi-stage centrifugal pumps of special design, of plunger lifts and gas-displacement pumps. None of these however, at least in its present form and as thus far developed, seems applicable to the problem of lifting oil from a depth of 10,000 ft. Because of rod stretch and other inefficiencies that increase with depth, many believe that present-day rod-operated pumps can not be used effectively at depths greater than about 7,000 ft. If today, we had to pump oil continuously from a depth of 10,000 ft. from wells producing under low reservoir pressures, there would be no mechanical device available for doing it. Engineering development of the methods and equipment for drilling deep wells have for the time being, outstripped the methods of producing oil from them after they are completed. There is developing at the present time however, a rodless type of pump actuated by hydraulic pressure, that seems to possess the elements of a successful deep-well pump. Engineering ingenuity will doubtless devise the means of pumping 10,000 ft. wells when it becomes necessary and profitable to operate them by mechanical means.

IN THE present article, it has been possible only to outline a few of the physical and engineering aspects of deep-well drilling and operation. The economic aspects of the 10,000-foot well: the question of whether the drilling of such wells today is economically justifiable, presents still another group of interesting problems that are discussed by Professor J. F. Dodge elsewhere in this issue of WORLD PETROLEUM.

Chitorani No. 1, Roumania's Deepest Well

Exploratory Test of Creditul Minier Carried to a Depth of 11,092 Feet was Demonstration of Engineering Skill and High Quality of Equipment Used.

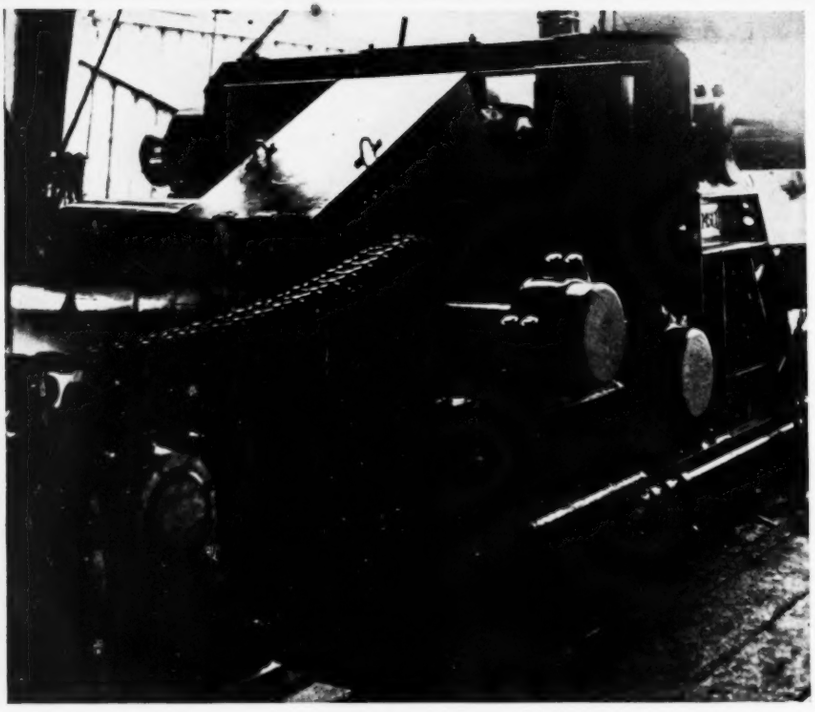
By Ovid Vesp. Erbiceanu

Engineer, Creditul Minier S.A.R.

ROUMANIA has been the scene of much deep drilling during the past few years and now possesses one of the world's deepest wells. This is Chitorani No. 1 which has been sunk to a depth of 11,092 feet (3,382 meters) in the course of drilling exploration conducted in the new district called Chitorani by the "Creditul Minier" S.A.R. at a cost of approximately $100,000.

The well is located six and one-half miles northeast of Ploesti and three-quarters of a mile north of the main highway Ploesti-Buzau. The objective was to test the anticline Valea Calugareasca-Chitorani. Geophysical and geological prospecting work showed the presence of the

Instrument panel on the rig of Chitorani No. 1; The Vernier was installed a few days later.



Side view of draworks with chain transmitting power from reduction gear.

anticline, whose axis runs approximately from east to west and is about four miles south of the top of the Boldesti-Harsa dome which was developed a few years ago and is now noted as the most prolific deep field in Roumania.

The producing horizon in the Boldesti-Harsa field is usually picked up at a depth of 7,500 feet, being from 700 to 1,000 feet thick and belonging to the lower Pliocene series. The discovery well came in a few years ago. Since then approximately 100 wells have been successfully completed with an initial production sometimes as high as 4,000 bbl. per day.

Chitorani No. 1 was spudded in on March 12, 1934, having in view the penetration of the Pliocene (Levantin, Dacian, Pontian and Meotian stages) formation and testing the underlying Meotian stage sands which are supposed to be oil bearing strata. During the drilling period, the geological conditions encountered were such that the well had to be drilled to a much greater depth than was originally anticipated.

By means of mechanical and electric (Schlumberger method) coring, which was carried out during most of the operation, the different geological formations and the dip of the strata were identified.

In the later stages of drilling great difficulties were encountered in the Chitorani well, due to the heaving shale formations which continuously caved into the hole as soon as the drill pipe was pulled out for changing bits. This was the only serious trouble encountered and was the delaying factor in the completion of the well.

Due to the skill of the drilling crews, the continuous attention of the engineers in charge and the superior equipment and material used, the drill pipe was stuck only on two occasions, each time being immediately freed without any attendant fishing job. On one occasion, however the loss of a drill collar caused a 19 hours fishing job. There were no twist-offs and no other fishing jobs during the entire drilling of the well.

Power Consumption and Drilling Speed

Date of record. 1934	Depth at 1st of every month; (feet)	Drilled during the month; (feet)	Average daily progress during the month; (feet)	Electric power consumption: up to the first of every month cumulated kwh.	Electric power consumption: kwh/foot drilled	Remarks
Mar. 12.....	0	0	0	0	0	
Apr. 1.....	3,650	3,650	182½	26.321	7.2	16-inch string landed and cemented.
May 1.....	6,297	2,647	88.2	82.704	13.1	Drilling; drill pipe changed.
June 1.....	8,178	1,881	60.7	137.770	16.8	8⅝-inch string landed and cemented.
July 1.....	10,437	2,259	75.3	225.056	21.6	Drilling.
July 28.....	11,092	655	23.4	308.321	27.8	Drilling hindered by heaving shale.

Subsurface Operations

In drilling the well only fishtail bits were used with drill collars ranging in length from 20 to 60 feet. A string of A.P.I. Grade "D" 6⅝ in., 31.9 lbs./ft. drill pipe was constantly in use from surface to 5,363 ft. (1,635 m.). Here the hole was reduced, and the drill pipe was changed to A.P.I. Grade "D" 4½ in., 16.6 lbs./ft. this size being used all the way to the final depth of 11,092 ft. (3,382 m.).

Information concerning size of hole, casing and drilling progress is given in the accompanying diagram. After cementing in the shallow, hand-dug well a 25 in. riveted string of casing at 61 ft., the mechanical drilling was started. A regular 21 in. fishtail bit with a 40 ft. drill collar made up of two pieces and a 6⅝ in. drill pipe drilled the hole to 666 ft. A surface string of 16 in., 78.4 lbs. (116.6 Kgr/m.) was cemented at 594 feet. The hole was then reduced to 14¾ in. and drilled down to 5,363 ft. (1,635 m.). Here, on account of returning to the 12 in. string of casing which was originally contemplated to be run, the bit was reduced to 11⅝ in. (295 mm.) and the drill pipe changed to 4½ in.

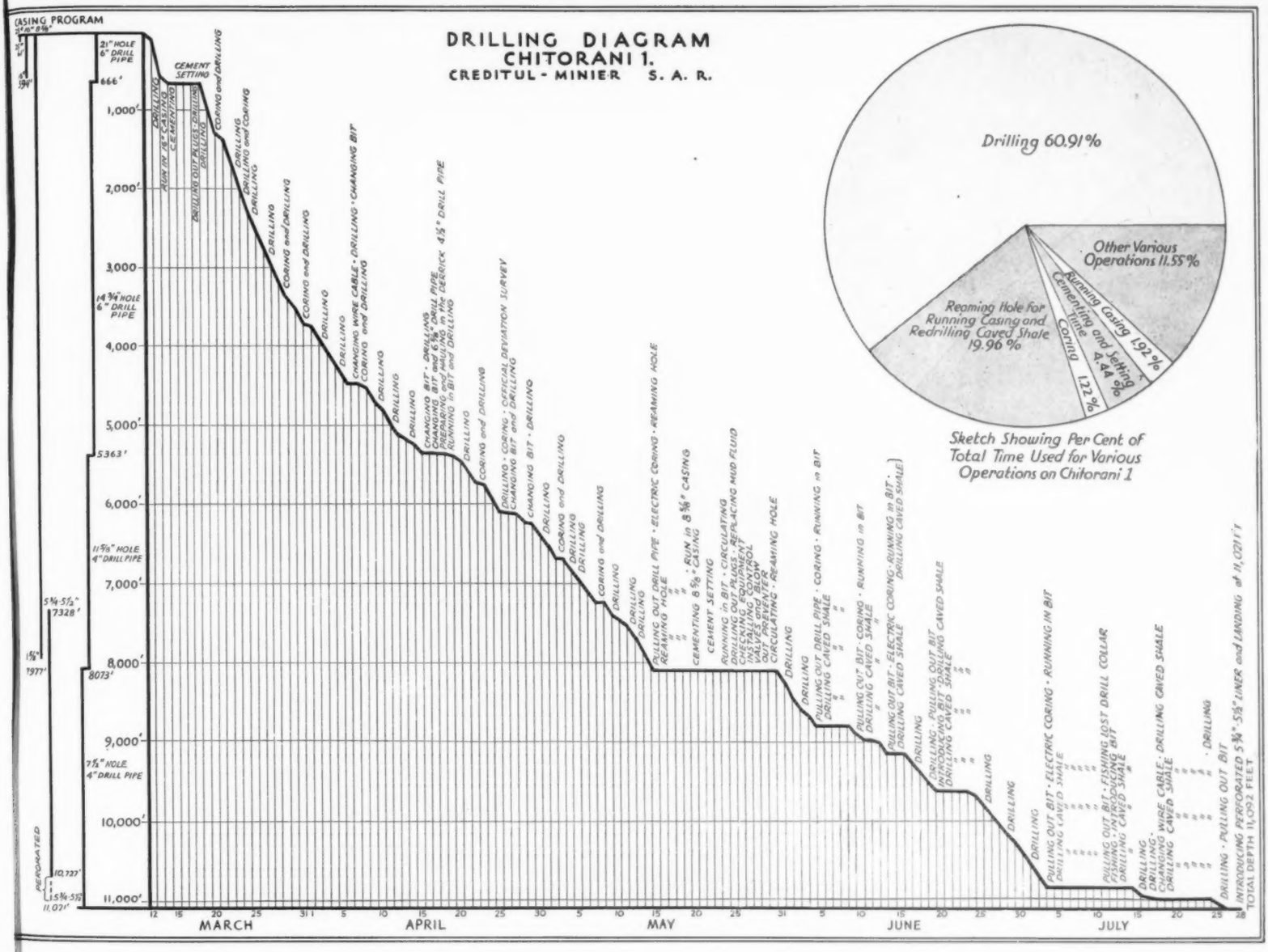
A 5 9/16 drill collar was made up of two pieces and with 90 ft. of 5 9/16, 25¼ lbs. drill pipe, on top of the drill collar, to add rigidity and weight to the lower portion of the drilling string.

Drilling was continued to 8,073 ft. (2,461.20 m.) where a 8⅝ in. water string was cemented at 7,977 ft. and the hole correspondingly reduced to 7½ in. using the regular fishtail bit and a 40-ft., 4½ in. two piece drill collar. After 10,800 ft. (3,292.40 m.) only one 20-ft. drill collar was screwed above the 7½ in. bit, down to 11,092 ft.

As soon as the final depth was reached, a string of 5¾ in.–5½ in., combination liner was run down to 11,021 ft. (3,360 m.). This liner was perforated from the bottom to 10,727 ft., then a cast iron baffle plate was placed at 10,690 ft. Immediately above this, a cementing nipple with outside opening ports was inserted, the upper portion of the string having its top joint at 7,329 ft. (2,234.40 m.).

Finally, a long tapered tubing was suspended on August 6, 1934 with the bottom at 10,680 ft. (3,256 m.), carrying a lower portion of 3,855 ft., 2½ in. A.P.I. exterior upset tubing, the balance being 3½ in. A.P.I. exterior upset tubing.

Only part of the casing used was of A.P.I. standard specifications. The 16 in. string was inserted casing 78.4 lbs. The 8⅝ in. string was all A.P.I. inserted casing



grade "D", the lower 4,762 ft. (192.3 m.) being 38 lbs., and the upper 3,215 ft. (1253.75 m.) being 36 lbs.; giving a total length of 7,977 ft., weighing 297,700 lbs. Two joints off the bottom, a specially designed home-made cement floating valve was inserted, with a bronze ring acting as a support for the cementing plugs.

The 5¾ in.–5½ in. combination liner consisted of Grade "D" 2,280 ft. inserted casing 5¾ in., 22.5 lbs. on bottom and 1,412 ft. inserted grade "C" 5½ in., 15.8 lbs. casing with a specially designed left-hand joint adapter at the top.

On account of the short time allowed for running in the liner, it was run on drill pipe and landed at 11,021 ft.; 71 ft. above the bottom of the hole. It was impossible to lower it to the actual bottom, due to the heaving of the shale. Because of this, circulation could not be made even with very high pressure. The cementing job, therefore, was not carried out. After landing the liner, the drill pipe was backed off from the left-hand joint.

Before running in any of the casing strings, the hole and the mud fluid were properly conditioned, no difficulty being experienced in landing the strings of casing at the predetermined depths.

Regular and automatic core barrels, as well as electric coring, were used with recovery averaging 85–98 percent.

Drilling fluid was kept under close control at all times. Natural fluid was used all the way, no mud substitute, or chemical materials except ferric oxid dust being mixed with the mud to lessen the pump pressure when the 8⅝ in. string was cemented.

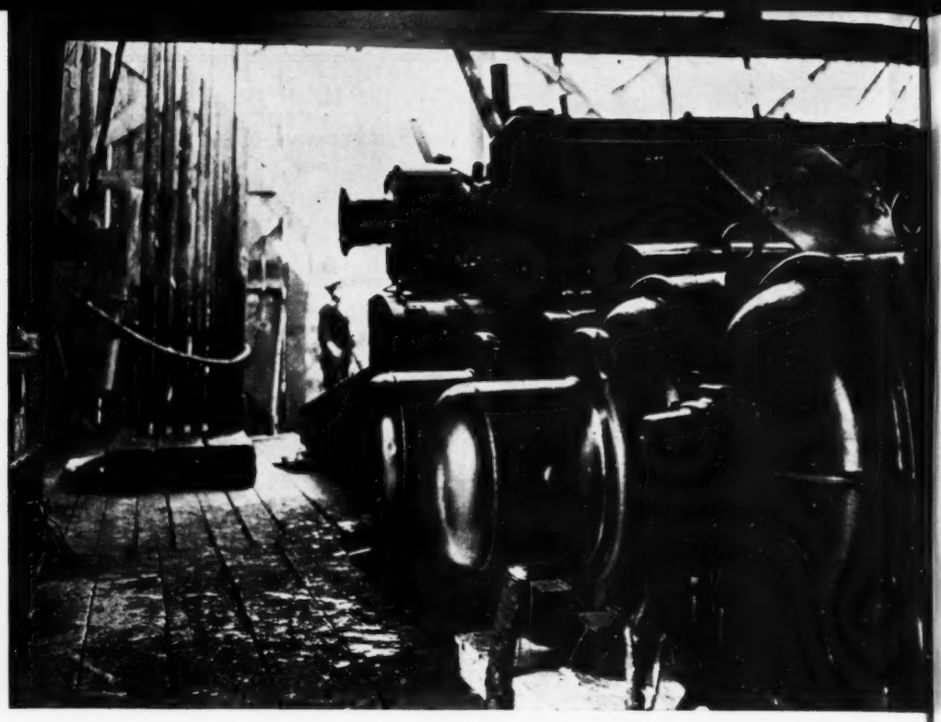
As no gas under high pressure, or oil showings, were disclosed during the drilling, the weight of the fluid was held within the ranges of 72 to 75 (1.15–1.2 sp. grav.) pounds per cubic foot.

Drilling progress varied, decreasing naturally during the latter part of the job. Notwithstanding the abrasive action of the hard sand and conglomerate gravels drilled through the Levantin stage above the 2,265 ft. (690 m.) horizon, daily drilling exceeded at times 400 ft. On April 1, 1934, twenty days after the well was spudded in, the total depth was 3,650 ft. (1112.80 m.) giving an average of 182½ ft. (55.64 m.) drilled per day. Below 10,868 ft. (3300 m.), in the hard sandy formation of the Meotian stage, the performance was still very good, averaging 40 ft. per day.

The monthly record of the average drilling, together with the electric power consumption per foot drilled, is given in the accompanying table.

Total depth = 11,092 ft.: Total electric power consumption, including the running in of the 5¾ in.–5½ in. combination liner, up to July 28, 1934, amounted to

Chitorani No. 1; auxiliary pumps and cement houses are located to the left of the picture.



Side view of draw works and twin electric motors on the Roumanian deep well.

308,321 kw. hours, representing an average of 27.8 kw. h. per foot drilled.

In order to appreciate better the performance it must be kept in mind that in the course of the month of June and July, 26 days were spent in re-drilling the caved shale which obstructed the hole. Each time after changing the bit it was necessary to drill down the caved shale before reaching the previous bottom.

During this period, although the drilling mud at pump intake was maintained at 75 lbs. per cubic foot, the mud returns obtained from bottom, when the bit was working hard in the caved shale, were so charged with solid shale particles that the fluid weighed 85 lbs. per cubic foot. Considerable quantities of these pea-sized particles were piled up at the vibrating screen discharge and it was estimated that approximately 3,000 cubic feet of solid particles were collected.

From an economic standpoint it is important to note that for these 26 days of supplementary work, 79,700 kw. hours electric power were required. This represents 26 percent of the total 308,321 kw. h. power consumed.

On account of the heaving shale the last core barrel successfully run was at the depth of 7,260 ft. (2213.30 m.). All attempts made subsequently to core at greater depths failed due to cavings filling the hole. On one occasion this resulted in a stuck core barrel which fortunately was freed immediately without a fishing job.

In the lower portion of the hole where cavings prevented running the core barrel it was found that the light instrument of the Schlumberger electric coring method could still be run successfully. This enabled the operators to keep the record of the formation penetrated. Due to the saving in time of running the electric coring apparatus, the shale did not have time to close in the hole.

In the opinion of the writer much credit must be given to the company's welding plant crew for the quality of the work done in dressing the bits with hard metals as a result of which only 38 fishtail bits were used from surface to bottom.

Careful attention was paid to control of vertical deflection of the hole and this resulted in a deviation no greater than 2 deg. although hard formations with a dip of 68 deg. maximum were drilled through in the upper portion of the hole.

Surface Equipment

As usual in the practice of larger operating companies in Roumania, the derrick floor was elevated at a height of 8¼ ft. above the ground and was supported by heavy concrete foundations and wooden beams. The square ground surface underneath the derrick floor was cemented around the central cellar.

The derrick, motor and pump houses were of wood, the derrick being 27 x 27 ft. at the base by 121 ft. high.

Blow-out preventers with remote control and control valves were installed providing ample protection in case of emergencies.

A four-shaft, eight speed draw works of the latest type on the market was used. This naturally provided two selective speeds at the rotary machine.

A new type of multi-lever equalized brake with standard brake lining gave good results down to the bottom of the hole. For speed and safety an automatic cathead of the latest type was used.

A completely new enclosed rotary machine of the latest design was used during the drilling of the well.

Double deck crown block and heavy type traveling block with 10 lines reeving were used in the latter part of the drilling. Wire lines of 1⅛ in. in diameter proved very satisfactory for all heavy loads handled. The hook used was 9 in. carbon and 9 in. alloy steel. In drilling the upper part of the hole a 6 in., 110-ton swivel was used, while for deeper operations an 8 in., 150-ton swivel was employed. Automatic slip type elevators and spiders handled the casing strings. Conventional type rubber hose gave good results, although a steel hose was always ready for use should an emergency arise.

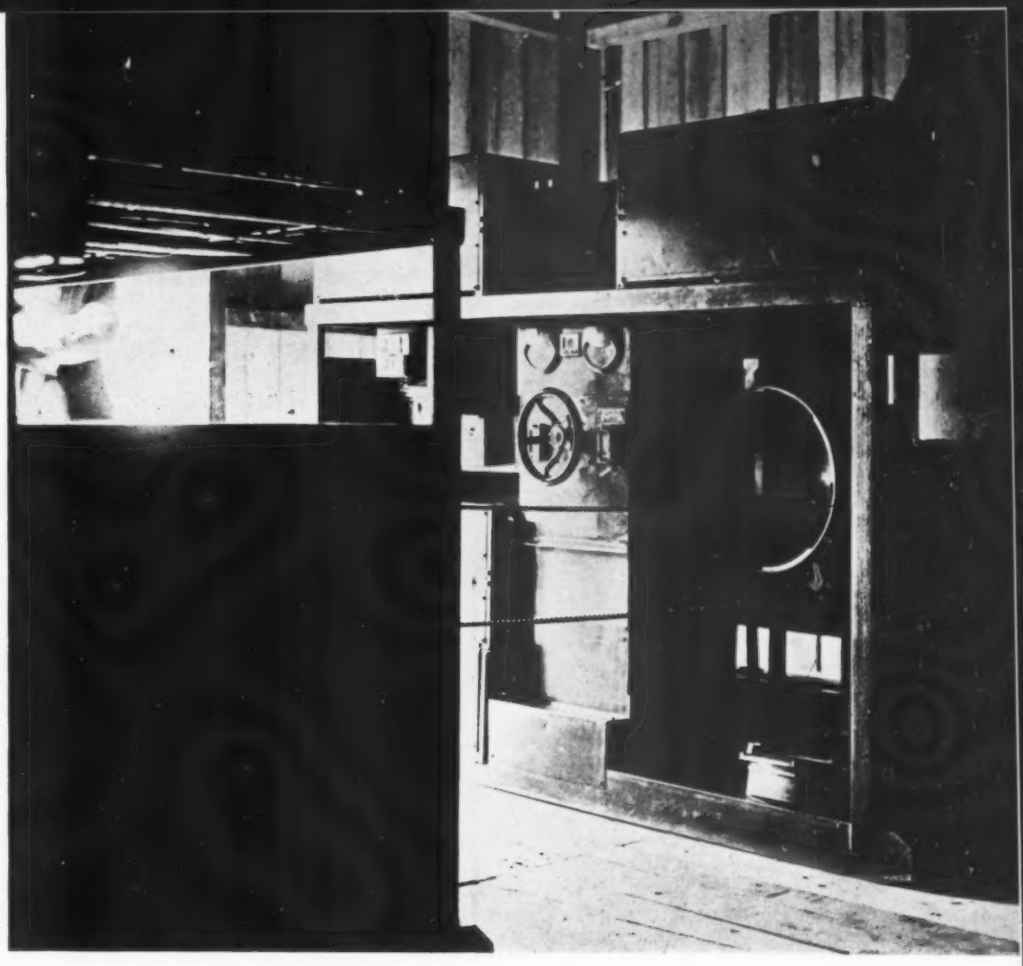
All motive power was furnished by electric motors. The drawworks were actuated through a regular non-differential reduction gear, by two 80 kw., 500 volt electric motors. In drilling, only one motor was worked while for pulling or running in both were under tension, at will. This feature, controlled by a switch at the hand of the driller, provided plenty of power for heavier work and speed, as well as great economy in power consumption for lighter operations.

The electric equipment was so designed that these motors were capable of 15 selective speeds forward, and five speeds in reverse, at the driller's will. By means of this wide range of speeds available, combined with those of the drawworks, ample satisfaction was experienced in drilling and coring various formations at different depths, at the same time providing high speed in handling the drill pipe.

Separate adjustable cutouts for shutting off automatically the electric motors when critical loads were exceeded controlled the torque and stress imposed on the drill pipe. An automatic red lamp warned the driller when the electric motors were so overloaded that the cutout relays were on the point of being shut off. Indicating and recording kilowatt meters indicated to the driller the power being developed by each electric motor.

Control of the weight carried on the bit was provided by using a customary indicating recording weight indicator with Vernier.

Two 7 in. x 18 in. slush power pumps, driven by 80 kw. electric motors, were installed. In addition, two smaller 6¾ in. by 14 in. power driven pumps were kept in reserve for auxiliary work. Relief valves on the discharge line completed the pumping equipment.



Electric wiring house showing central cables running out to derrick floor.

Great care was exercised in circulating a good clean fluid by using a vibrating screen. This was a considerable help in minimizing stuck drill pipe, obviating replacements of mud and decreasing the wear on pump parts.

An indicating and recording mud pressure gauge was constantly in view of the driller, together with the customary gauge indicating the pressure of the water circulating in the cooling system of the brake rims on the drawworks.

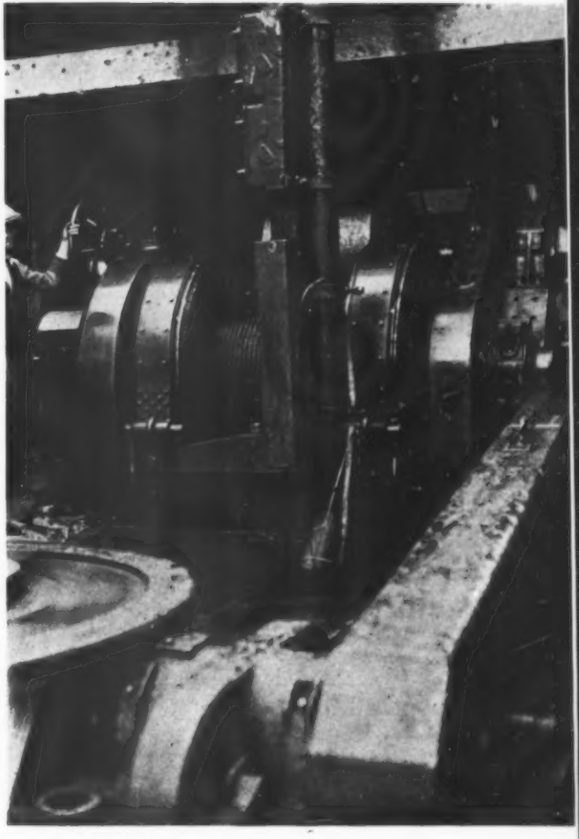
Results

THIS wildcat well has proven that the lower Pliocene formations are to be found at a very great depth, even in the proximity of the axis of the anticline. From the considerable dip disclosed by the cores it is supposed that the formations sink rapidly toward the south.

The objective of Chitorani No. 1 was to indicate whether or not the Meotian sands were productive. This horizon has been identified at 10,868 ft., after many difficulties. The production tests subsequently made, have shown that the Meotian sands at this point do not contain oil on the southern flank of the Chitorani anticline.

Creditul Minier S.A.R. is now rigging up Chitorani No. 2 with the intention of exploring the northern flank of the anticline.

Front view of drawworks: driller has his hand on wheel controlling the speed of motors



Cementing the World's Deepest Casing

Careful Study and Preparation Against Every Predictable Contingency is Essential in Setting Casing at 10,000 Ft. Importance of Establishing Circulation.

By C. P. Parsons
Halliburton Oil Well Cementing Company

ONLY ONE string of casing has been run and cemented below 10,000 ft. Successful in every detail, that exceptionally long string was set at 10,300 ft. by the Gulf Production Company in its McElvoy No. 103, in the West Texas area. That accomplishment alone is a tribute to the skill of the company's field organization, but many laurels are due the management for courage and patience in supporting that skill. The combination has made it possible to continue the well down to its present depth of 12,174 ft. (April 1) making it the deepest in the world—and still going!

Before describing the running and cementing of the 10,300 ft. string of casing it may be mentioned that only six strings of casing had previously been run below 9,000 ft. in various wells throughout the world, but of these only one half were successfully completed.

In such deep casing jobs a long list of mechanical details must be considered, understood and prepared for. The failure of only one detail may cause the immense investment in the well to be lost. Operation of the equipment demands skill and alertness on the part of the drilling crews. Purchase of material requires careful selection, and fortitude on the part of the officials controlling the company's pocketbook must be anything but "mild."

Even chemistry has come to play a part in the undertaking. No modern well can be carried successfully to great depths without an understanding of the physics and chemistry of the drilling mud. Mud is no longer just "mud," now that it contains such high sounding things as centipoises, colloids, peptizers, dispersive phases, etc.

At the time of running the 10,300 ft. string of casing the bottom of the hole was at 10,633 ft. and 10–¾ in. O. D. casing had been set and cemented with 1,000 sacks at 4,100 ft., leaving 6,500 ft. of open hole. Inasmuch as the casing was being run to make a production test it was decided to set same at 10,300 ft. instead of running it to bottom. An electric instrument had been run to measure the resistivity of the formations exposed in the open hole. The drilling mud weighed 10 lbs. per gallon and had been considered in proper condition to assure breaking circulation after the casing was run. Temperature readings had been obtained in the well throughout the mud column, to be used in making preparation against premature setting of the cement while being pumped into place behind the casing.

Several tons of ice were used to chill the water to be mixed with the cement.

The casing was 7–⅝ in. O. D., 34 lb., Grade D, A. P. I. specification. A guide shoe was placed on the bottom joint, a float collar was placed between the first and second joints and another between the second and third joints. The total weight of the 342 joints of casing was 350,000 lbs. In order to handle the casing, the crown block and traveling block were strung with ten lines, 1–⅛ in. diameter, and the rotary table had been removed and a special steel foundation built to support the casing spider. A slip type elevator was used.

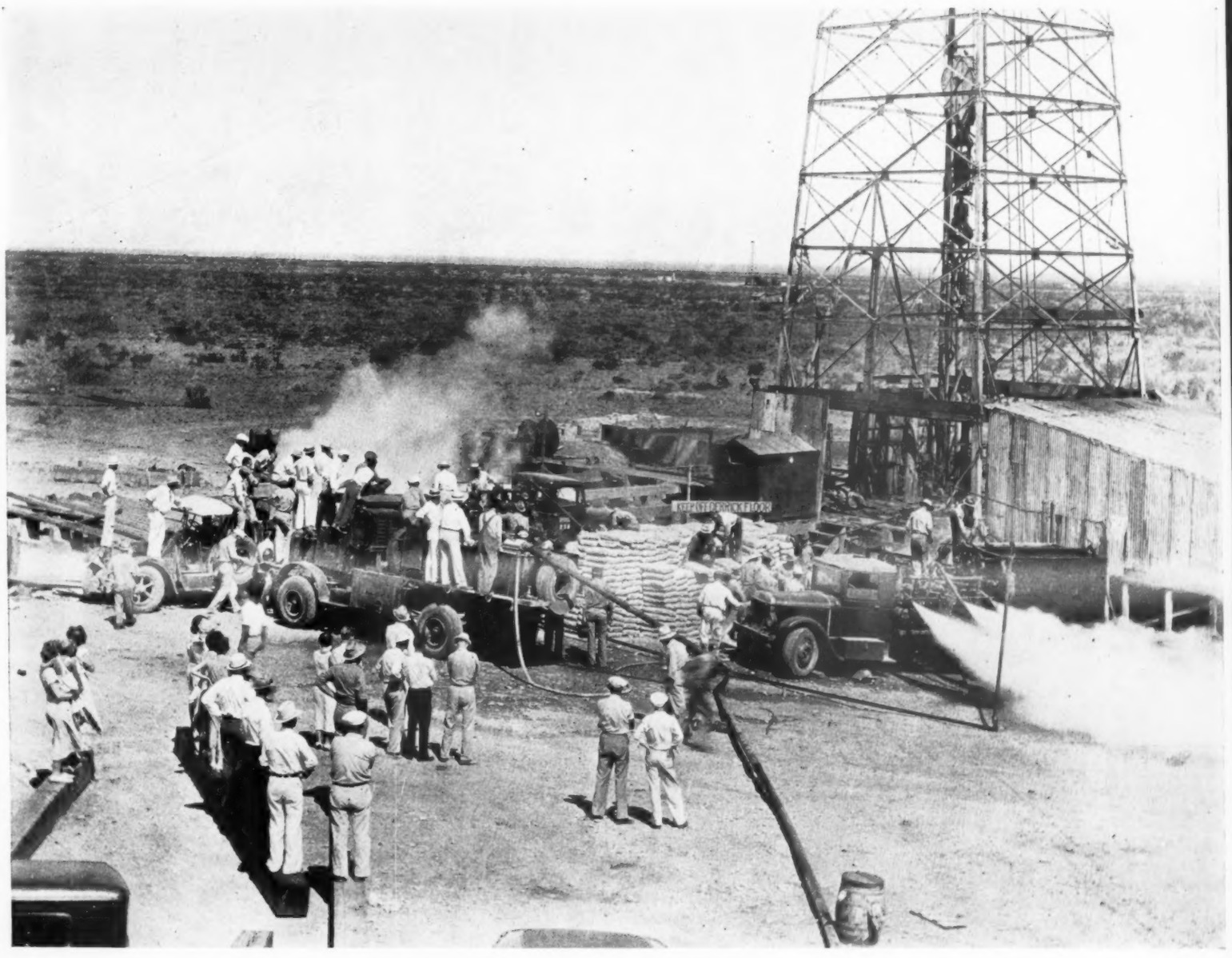
In order to determine the sag of the derrick during the casing job, a transit was stationed several hundred yards from the derrick and focussed on a marker attached to the crown block. An engineer observed the sag and found the maximum to be less than an inch.

The casing was run in 19 hours. Four complete drilling crews were used, working in short shifts. Although there was no precedent for such a long string of casing and although extreme care had to be exercised throughout the job, no undue difficulty was encountered.

In the meantime, the cementing equipment had been prepared and tuned up for the cementing job. Water lines had been laid of sufficient size and the water supply made available to furnish the cementing truck with sufficient water during the mixing operation. Steel connections were laid between the cementing pumps and the well.

After running the casing and before starting the cementing operation in a deep well, however, there is a very important step to be accomplished. It is to establish circulation. Just a few years ago it was not considered a serious factor but today it is vital and unless an operator has learned its importance through expensive failure or knows of the experiences of others, it is very likely to be overlooked and may result in serious loss. As mentioned, one half of the six strings of casing which had previously been run below 9,000 ft., were not carried to successful completion. Although the casing was landed, circulation was not established and, consequently, it was not cemented.

One important factor to be considered is the physical properties of the drilling mud, the resistance to flow of the mud caused by mechanical restrictions and obstructions in the float mechanisms inside the casing and the restrictions of the annular space behind the casing. Another is the resistance of permeable formations in the well below the casing shoe or upward behind the lower part of the casing to start taking the drilling mud when high pump pressures are applied to overcome the resistance of the drilling fluid itself and of the mechanical restrictions. Such permeable formations may not take the drilling fluid under normal pressures during the drilling operation, an effective seal having been built up on the surface of the formation by the mud during the drilling operation but which may not be effective when additional pressure is applied. This loss of fluid into some permeable formation in the



Cementing the final string of casing to be run below 10,000 ft. One thousand sacks were placed in one hour and eleven minutes behind casing set at 10,300 ft.

lower part of the well when a pump pressure of 1,500 lbs. was applied in attempting to establish circulation was the cause of one of the failures mentioned. Briefly, the resistance of the drilling mud against flow was greater than the resistance of some permeable formation in the lower part of the well. The formation would not take any mud up to 1,500 lbs. pump pressure, but at that pressure it took all that could be pumped into the casing.

There are several lines of action to assure establishing circulation after the casing is run. Among them are: building up effectual seals on permeable formations, while drilling, against high pump pressure which may later be applied; minimizing the mechanical restrictions inside and outside of the casing; and conditioning the drilling mud so that its resistance to start moving is controlled to the lowest point consistent with other desirable properties.

For establishing more effectual seals of permeable formations while drilling, one of the latest developments is a new fibrous material, carefully selected as to type, lengths and combination of fibers, now being successfully used in the Fitts Field in Oklahoma, where lost circulating problems are aplenty.

As to the conditioning of mud for breaking circulation, no specific formula can be made of a general nature, due to the widely varying physical and chemical properties of muds in different wells and in different areas. There are two physical factors in a drilling mud, however, which are most important in establishing circulation. One of them is the suspension of solids in the mud, which, if insufficient, will allow settling of the solids to some point of concentration either on top of the upper float assembly in the casing or some restricted place behind the casing. The other property is what is now called "gelation," which is the factor that mainly affects the resistance of the mud to start moving. This "gelation" of a mud is noticeable after agitation of the mud ceases. When the mud becomes quiet, a gel structure starts setting up, stiffening the mud. This gel structure is readily broken down after agitation is applied. After the gel structure is broken down viscosity becomes the main factor affecting movement of the mud.

Different drilling muds may not only have varying degrees of "gelation" but also may have different rates of time for

the setting up of the gel structure to a given point. This gel structure, or "gelation," is at present being measured in units obtained by means of instruments designed for measuring surface tension but adapted for measuring the resistance of the gel structure within the mud sample against the starting of movement of that part of the instrument submerged in the mud. The amount of pressure required to start its movement is measured by the instrument. The treatment of drilling muds to lower the "gelation" must be accomplished without affecting desirable qualities of the mud. The addition of water is one of the best mediums for lowering the "gelation" but if used too freely may cause settling out of the solids and may also lessen the weight of the mud too much. The use of tannic acid, quebracho, and other simple chemicals has been found to be effective in controlling the "gelation" without materially affecting the suspension or weight. Due to the fact that muds vary from well to well and from depth to depth in a well, samples of a mud to be used at a given job are given a "cut and try" test with the samples of chemicals until the proper combination is found. These tests and actual treatment, if necessary, should be tried before withdrawing the drill stem on the last trip prior to running casing.

When the 10,300 ft. string of casing was landed, the circulating pumps were connected up to the top of the casing to break circulation and the stand-by cementing outfit was ready with a quick-change hook-up to apply high pump pressure if necessary. Everyone was considerably relieved when circulation was established at the unexpectedly low pump pressure of only 750 lbs., which showed that the physical properties of the drilling mud and the mechanical restrictions had been carefully considered and controlled.

After circulation was established on this particular well it was maintained for about 15 minutes, during which time a careful check was made on the pump pressures. No undue change apparently had taken place in the mud, due to settling, and it was ready for cementing.

Because of the speed with which a cementing job of this nature must be carried out it may be said that perhaps two thirds of the success of the job lies in careful preparation.

Several conferences had been held as to breaking circulation, type of cementing equipment, amount of cement to be used, methods to speed up the cementing operation to overcome the effect of time on the setting of cement, and methods to overcome the effect of temperature on the settling of cement.

One result of these conferences was a decision to use 1,000 sacks of plain portland cement mixed with chilled mixing water. Three cementing trucks were provided, two of them being of the new three-pump steam type for mixing the cement and the other a high-pressure motor-driven type to stand by for the purpose of instantly applying high fluid pressures if necessary.

As a precaution against the accelerating effect of high temperature in the well on the setting time of the cement a sufficient amount of ice had been put into the mixing water prior to the cementing job to chill the water to a temperature of 40 deg. F. The purpose of using chilled water was two-fold: first, the chilled water retards the setting of the cement; second, the cement slurry is more fluid at a given weight per gallon when mixed with chilled water as compared with water of higher temperature.

As soon as circulation was stopped, the swage was disconnected from the top of the casing and replaced by a cementing head which contained the top cementing plug, to be instantly released as soon as the thousand sacks of cement were pumped into the casing. This change took only a few minutes and was facilitated by the use of "quick change" unions connecting the steel hose.

The mixing of cement then started and as soon as all of the cement slurry was pumped into the top of the casing, the top cementing plug was instantly released from within the cementing head and followed by the measuring line. The cement slurry was pumped down the casing by the slush pumps in very good time, with the high pressure pumps of the "stand-by" cementing outfit instantly ready to apply high pressure if necessary to force the cement into place if the pressure required was greater than that of the slush pumps. This was not necessary as the 1,000 sacks of cement went through the floating mechanisms in the float collars and into their proper place behind the casing at a final pressure of only 1,100 lbs. per square inch. The total time for the cementing job, from the time the first sack was mixed until the last sack reached its proper place in the well was one hour and eleven minutes, which compares very favorably with the time that used to be required for cementing jobs at less than half the depth.

The cement was allowed to set for several days and then the floats and the 70 ft. of cement that was intentionally left in the casing were drilled out without any difficulty.

The very favorable results on the first string of casing to be run below 10,000 ft. shows that the chain of mechanical details necessary in the successful running and cementing of such long strings of casing can be understood, prepared for and executed, lending considerable hope for successful performance at even greater depths.

Out of those details, the least understood in deep casing jobs, is "establishing circulation." It is a vital factor expensively overlooked in a number of previous deep wells—a sort of bridge between the finish of the casing job and the starting of the cementing job. To disregard it in a deep well may jeopardize a huge investment.

▼

Casing Developments

IN A STUDY of the question as to what is the limit to the length of the casing, reported to the American Institute of Mining Engineers, Messrs Graham and Smith of the National Tube Co. discuss the factors that enter the problem. At present the best steel prescribed for casing by the A. P. I. is Grade "D" with a minimum tensile strength of 95,000 lbs. With a safety factor of 2 and a steel of about 105,000 lbs. average tensile strength a casing could be set at approximately 15,442 ft., if the joints were as strong as the body of the casing. Joint strength is therefore the critical factor.

With deeper wells in prospect the oil engineers are therefore asking the pipe manufacturers two questions: Is there a possibility that stronger joints can be designed without resorting to more costly steels? And without sacrificing too greatly the tensile properties of the joint, can its design be changed to allow more clearance in the open hole below the next larger string and thus avoid costly underreaming?

Graham and Smith answer both questions in the affirmative. By upsetting the ends of casing, joints can be made that will develop the full strength of the casing wall; and where greater clearance is desired thin-walled special steel couplings may be used without too great expense or sacrifice of strength.

Drill Pipe Stresses and Failures

Structural Problems and Difficulties That Have Been Overcome in Developing Drilling Pipe to Stand the Tremendous Torsion and Compression Strain at 10,000 Feet.*

FROM the beginning of the oil industry and particularly in the past few years, a problem of increasing seriousness has been the dependability of the drill pipe which made up the rotary drilling shaft. Service demands have increased rapidly with deeper holes, broader bits, and greater power of prime movers. Total cost of drilling a well has increased greatly, and consequently the delays resulting from drill pipe failures have assumed a commercially serious aspect.

From the very outset, torsional stresses in drilling made it evident that welded low-carbon pipe was not sufficiently strong. The necessity for low-carbon content for welding operations did not permit any increase of strength by raising the carbon. Heavier pipe weights were consequently developed.

Unsatisfactory service of welded pipe early pointed toward the desirability of seamless tubing and it may almost be said that the development of rotary drilling and the seamless tube industry have proceeded hand in hand. Today the use of welded pipe for rotary drilling is almost unknown.

Through a desire to increase the strength of drill pipe without sacrifice of ductility, there has been a development toward an increase of manganese and a reduction of carbon. This has progressed until manufacturers are regularly producing drill pipe with manganese up to 1.25 and 1.50 percent. Some further advance in this direction is possible, but it must be remembered that manganese is an alloy that increases the cost of the steel, just as surely as nickel, chromium, or other alloying elements.

Some work has been done with alloys other than manganese. Molybdenum, an expensive alloy, has been tried with some degree of success. Such work is dependent on its economic justification, and the willingness of the oil producer to recompense the steel manufacturer for his extra costs.

Table No. 1 illustrates the development that has taken place in drill-pipe material. While the results from special developments such as normalizing, heat treatment and use of alloying elements are not included here, a large percentage of the drill pipe in use today will be as shown under Grades "C" and "D."

Table No. 1

Physical Properties and Chemical Composition of Representative Seamless Pipe

	Low Carbon	Intermediate	A.P.I. Grade C	A.P.I. Grade D
Carbon	.12	.24	.40	.45
Manganese	.45	.75	.75	1.20
Phosphorus	.017	.017	.017	.017
Sulphur	.037	.037	.037	.037
Silicon	.03	.16	.18	.19
Tensile	58,000	70,000	90,000	105,000
Yield	38,000	46,000	55,000	60,000
Elongation in 2"	44	38	30	30
Elongation in 8"	.....	.....	.....	.....
Reduction of Area	62	55	45	48
Impact Izod	60	45	15	20

Drill pipe was at first straight wall at the threaded ends, that is, not upset. To compensate for the loss of wall thickness and notch effect due to threading, upsetting of the ends was introduced. This, together with improvement in threading practice, served to reduce materially the proportion of failures occurring at the joint.

The original plain-end drill pipe had been reasonably satisfactory as to grain structure. Hot-upsetting, however, left the pipe in and about the ends structurally weakened. To overcome this, the ends were afterwards normalized. End-normalizing is not entirely satisfactory, however, since the local heating inevitably leaves internal stresses and zones of varying grain structure in the tube. These constitute a location for physical weakness and a fair proportion of twist-offs may be expected to occur at the junction of the upset end and body of the tube on end-normalized drill pipe.

To eliminate this weakness, at least one manufacturer has provided facilities and adopted the policy of full-length normalizing after upsetting. This method produces a very satisfactory and uniform grain structure with maximum physical qualities throughout the tube. With the uniform structure produced by full-length normalizing, and with the reduction of area and notch effect of the threaded section compensated for by increased wall thickness, a drill-pipe tube may be expected to function normally. Failures should not occur at one point in the tube length much more frequently than at any other point.

Metallurgical and mechanical improvement of drill pipe having reached a point where obvious weaknesses have been eliminated, further development must be based on a detailed survey of the probable cause of failure.

The usual stresses entering into drill-pipe service are:

1. Tension.
2. Compression.
3. Bending.
4. Torsion.

With respect to the rate of application of force, the above stresses may be classified as follows:

1. Static—Forces of a low order uniformly and continuously applied.
2. Fatigue—Forces of a moderate order applied over a long period of time.
3. Impact—Forces of a high order instantaneously applied.

Under smooth operation the bit, drill pipe and prime mover constitute a mechanical system in rotation with a definite momentum. When the bit "seizes," or "stalls," the drill pipe and prime mover tend to continue rotation and the entire "flywheel" momentum of the drill pipe and prime mover delivers a shock blow which must be borne by the first joint of drill pipe above the bit. Held by the bit, this joint must stand the maximum torsional stress and absorb its own energy of rotation by twisting slightly, evolving some heat and passing the remaining shock up to the next joint. In this way each joint in turn is subjected to a torsional shock, dissipates its share of the energy and transmits upward a gradually decreasing stress. By the time the shock has been "telegraphed" up to the surface,

*Condensed from a paper by H. W. Graham, general metallurgist of Jones and Laughlin Steel Corporation.

all the momentum of the string has been absorbed and there remains only the momentum and torque of the prime mover, which is inadequate to account for failure.

Analysis indicates that the reason for twist-off failures occurring mostly in the bottom lengths of drill pipe, lies in the fact that the gross force exerted through a stalled bit is applied first at the bottom-most length and decreases considerably as it is transmitted up the string, with consequently less likelihood of failure in the top joints. The concentration of force at one location, the necessity for its dissipation and the very short time available for dissipation, necessarily involve shock and torsional impact stresses. Such stresses may reach a high order of magnitude and easily account for twist-off failures. Analysis of the factors entering into such stresses should be helpful.

The magnitude of the stress imposed by sudden stoppage of the bit is a function of the distance between the longitudinal axis of the drill pipe and the mean circumference or radius of gyration of the tube. Any increase of diameter of the pipe rapidly increases the stress. This is understandable by envisioning a stone whirled about one's head on a string of given length. If the length of the string is increased the stone will strike a much harder blow if brought against some obstruction.

With the present-day tendency toward wells of increased depths, it is fitting to inquire into the order of stress induced by stoppage of the string at various drilling depths. As the well is drilled deeper the drill-pipe string is lengthened and the total kinetic energy of the "fly-wheel" system is correspondingly increased.

Figure 2 illustrates the rate at which this energy is built up when various sizes and weights of drill pipe are stalled in one-twentieth of a revolution from a speed of 75 r.p.m. The increase of stress is shown to be directly proportional to the increase of depth of hole. A study of this chart also illustrates again the effect of the diameter of drill pipe on the stress generated under the conditions shown. It will be noted that a 6⅝ in., 25.20-pound drill pipe at 4,000 ft., under the same conditions will be subject to stresses per square inch of cross section equivalent to those found in a 2⅞ in., 8.35-pound pipe at about 10,700 ft.

As mentioned previously, the radius of gyration, that is, the distance from the axis of the drill pipe to its mean circumference, is a potent factor in the amount of stress generated by stalling the bit. If the outside diameter is maintained and additional weight added to the drill pipe by enlarging the wall thickness, one might suppose that the increased cross-sectional

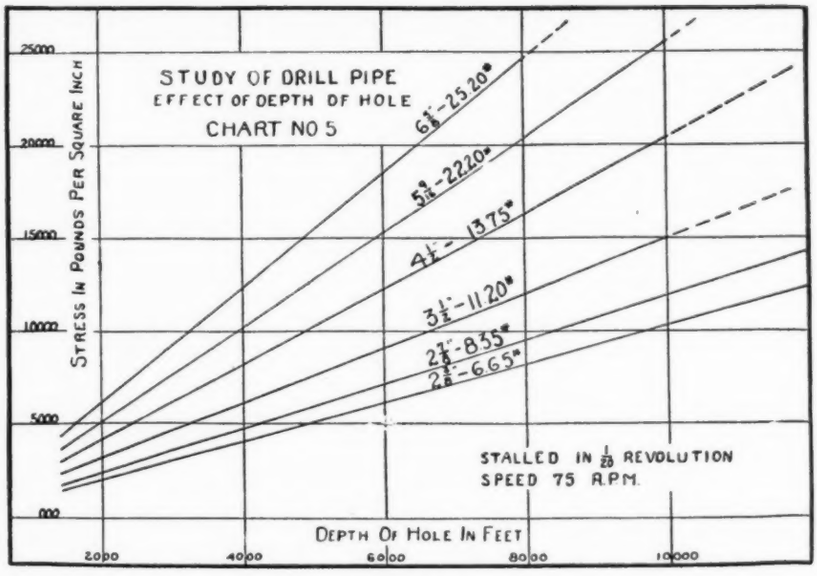


Figure 2

area would result in lower stresses per square inch when the string was stalled. In fact there is such an effect, but the momentum is also increased by the added metal and the stress per square inch of cross-section is lowered only slightly. The liability to twist-off appears to be decreased so slightly that it is doubtful if a field engineer is justified in specifying the heavier wall thicknesses, viewed from the standpoint of twist-off alone. If to this is added the consideration that the heavier drill pipe will be stiffer and thus assist in maintaining straighter holes, the specification of heavier wall thicknesses may perhaps be justified.

The speed of rotation of the drill pipe is obviously a large factor in the amount of momentum stored up in the string. The stresses induced by sudden stoppage therefore increase rapidly with increased r.p.m. For the purpose of speeding up drilling, it is of course desirable to operate at maximum speed, but there is in fast rotation increased danger of drill-pipe failure that does not exist at lower speeds. The greater risks and possible delays due to twist-offs at higher speeds must be balanced against the benefits that lie in speedier sinking of the hole.

In modern practice on very deep holes the diameter of casing is quite large, necessitating broad bits and consequent heavy drilling torque. This demands a pipe with very high torsional strength to pull the drilling load, and also very high ductility to resist torsional impact stresses when the bit is stalled. These qualities are more or less opposed and in the final analysis there must be some compromise between hard strength and soft ductility.

A metallurgical review of the mechanical, physical, chemical and thermal developments in the manufacture of drill pipe has been made, which has indicated the following:

MECHANICAL: From commercial welded pipe the industry progressed to heavier wall-welded pipe and finally to interior upset seamless.

PHYSICAL: From ductile materials of about 50,000 lbs. per square inch tensile strength, there has been a steady development to materials of about 100,000 lbs. per square inch tensile strength, with varying orders of ductility.

CHEMICAL: From commercial wrought iron and steel pipe of very low carbon (maximum about .10 C) low manganese content (max. about .50 Mn) there has been a gradual development to the present ranges of about .35/.50 carbon, and a manganese content of .60/1.50 or even higher.

THERMAL: From the ordinary "as rolled" finish to end-normalizing and subsequently to full-length normalizing.

An analysis has been attempted of the character and extent of the stresses entering into drill-pipe service. This has indicated that static stresses are relatively unimportant in causing failure of the pipe. However, dynamic stresses of the torsional impact type are shown to be capable of causing failure depending on conditions of service. The conditions most affecting these stresses are analyzed with the result that the following are shown to be major factors in service failures:

1. Abruptness of stalling.
2. Outside diameter of drill pipe.
3. Well thickness or weight of drill pipe.
4. Depth of hole.
5. Speed of r.p.m. of drill pipe.

ZUBLIN BITS = THE STAND BY

DRILLING UP IRON

BELRIDGE, April 1934: Four 5⅝" Cutters drilled up set of rock bit cones from 10,961 to 10,966 feet.

KETTLEMAN HILLS, April 1934: Five 12¼" K-99 and two H-50 Cutters drilled up and sidetracked full cone rock bit assembly from 7225 to 7309 feet.

LONG BEACH, Jan. 1934: One 9⅝" K-99 in sidetracking pipe made 8 feet on iron and junk in 12 hours. Eight bits of other makes had previously made 17 feet in 2 weeks.

KETTLEMAN HILLS, June 1934: Five 8⅜" K-99 Cutters drilled up full cone rock bit assembly from 8256 to 8274 feet in 31 hours.

KETTLEMAN HILLS, July 1934: Two 8½" K-99 Cutters drilled up full cone rock bit assembly from 7530 to 7534 feet in 8 hours.

KETTLEMAN HILLS, May 1934: Three 8⅜" K-99 Cutters drilled up rock bit cones from 7524 to 7538 feet in 22½ hours.

KETTLEMAN HILLS, Jan. 1935: Four 8½" K-99 Cutters drilled up 2 cones and made 11 feet in hard sand from 7931 to 7942 feet.

SIDETRACKING PIPE

KETTLEMAN HILLS, May 1934: Nineteen 5⅞" K-99 Cutters sidetracked drill pipe from 9984 to 10,265 feet.

KETTLEMAN HILLS, April 1934: Eight 8⅜" K-99 Cutters sidetracked drill pipe, drill collar and underreamer from 7989 to 8079 feet.

KETTLEMAN HILLS, April 1934: Six 8½" K-99 Cutters sidetracked 2 joints 6" drill pipe, drill collar, reamer and complete rock bit assembly from 6061 to 6135 feet.

BELRIDGE, Nov. 1934: Three 7⅝" K-99 Cutters sidetracked 240 feet drill pipe, drill collar and underreamer in 30 hours.

LONG BEACH, June 1934: Five 9⅝" K-99 Cutters sidetracked 390 feet of lost drill pipe.

DRILLING THROUGH CASING

RICHFIELD, Aug. 1933: After twisting off a mill in the hole, one 7⅝" K-99 Cutter went through the liner in 6 hours and made 180 feet of open hole.

LONG BEACH, Sept. 1933: One 12¼" K-99 Cutter off whipstock went through 13⅜" German Seamless pipe making 47" in 48 hours. A milling tool made 4" in 8 hours.

SANTA FE SPRINGS, July 1934: Two 7⅝" K-99 Cutters off whipstock went through casing in 16 hours.

LONG BEACH, Nov. 1934: One 7⅝" K-99 Cutter went through pipe and made 105 feet in 24 hours.

HUNTINGTON BEACH, Oct. 1934: One 7⅝" K-99 Cutter off whipstock and through pipe made 47 feet in 24 hours.

STRAIGHTENING CROOKED HOLE

KETTLEMAN HILLS, Sept. 1934: Hole off 2¼° at 6605 feet. Two 12¼" K-17 (Cross) Cutters reamed from 6410 to 6605 feet bringing hole back to 1°.

KETTLEMAN HILLS, Oct. 1934: Hole off 4½° at 3860 feet. Ratholed with three 5⅞" K-17 Cutters and reamed out with two 8⅜" H-50 Cutters to 4083 feet bringing hole back to 2°.

KETTLEMAN HILLS, Oct. 1934: Hole off 3° at 8428 feet. Five 8½" K-17 (Cross) Cutters reamed from 7860 to 8428 feet bringing hole back to 1°.

KETTLEMAN HILLS, Nov. 1934: Hole off 2½° at 8510 feet. Two 8½" K-17 (Cross) Cutters reamed from 8460 to 8510 feet bringing hole back to ¾°.

KETTLEMAN HILLS, Oct. 1934: Hole off 2¾° at 7358 feet. One 12¼" K-17 (Cross) Cutter reamed from 7150 to 7358 feet bringing hole back to 1½°.

KETTLEMAN HILLS, Oct. 1934: Hole off 2° at 7259 feet. One 12¼" K-17 (Cross) Cutter reamed from 7140 to 7259 feet bringing hole back to 1°.

K-99 Cutter

K-17 Cutter

G-62 Cutter

H-50 Cutter

S-20 Cutter

H-41 Cutter

UNIVERSAL ENGINEERING CO., Ltd.
2369 East Fifty-first Street, Los Angeles, California

DUKE & OCKENDEN, Ltd.
126 Southwark St., London, S. E. 1

FISCHBACH, ENQUIN y SIDLER
Moreno, 574, Buenos Aires, Argentina

For DRILLING

Deep Wells

SAFETY must always be the first consideration when depths exceed 9,000 feet, or when unusual hazards or difficulties are present — but modern practice demands also that tools be handy to use and economical to operate.

BJ Tools meet all these requirements. Their design is the result of years of experience—their construction is invariably of the highest quality materials —their successful operation is insured by exhaustive tests in laboratory, shop and field.

AT THE LEFT

Two new BJ Elevators for External Upset Drill Pipe, and the improved Type A BJ Center Latch Elevator for regular drill pipe. Here is Strength for the longest strings ever run, plus convenience due to perfect balance and long operating handles on the Center Latch Types; and a Side Door which closes automatically when the "upset" enters the elevator.

The BJ Tong illustrated is an extra-heavy type for combination use on drill pipe or casing, with integral cast handles and other fast-operating features.

A new "staggered-tooth" disc enables BJ Disc Bits to cut faster, straighter, full-gauge hole in all except the hardest formations.

And now, a "drilling" Safety Joint by BJ which insures a positive breaking point and minimizes the dangers of fishing jobs on costly deep wells.

IN CENTER

BJ Triplex Hooks—for drilling or setting heavy strings of casing—are made for 300-ton loads in deep wells, and for average drilling where 150-ton capacity is sufficient. The design includes a lower hook for the swivel bail and a side hook for each of the elevator bails or links. The new "locking arm" provides great strength and also prevents swivel bail or links from "jumping" the hook. Enclosed relief springs; a yoke which easily threads through the becket of the traveling block; a universal-joint action; and grease-gun lubrication fittings all combine to make the BJ Triplex Hook the fastest-selling hook the oil country has ever known.

BJ Weldless Links—are forged from a single piece of steel and heat treated to provide strength exceeding that of the derrick. Furnished with or without handles in a wide range of diameters and lengths.

BJ Side Door Slip Elevators—are constructed with four extra large slips which set automatically when the collar is reached, or may be set manually at any point below the collar. The slips can be locked in set position. Side-door construction permits removal of elevator while cement is setting. Perfect balance is responsible for fast, easy handling of the longest strings of large diameter casing.

DRILLING TOOLS

PRODUCING

And, after your well is put on production, there is the same vital need for tools and equipment which will speed up the handling of tubing or rods, but always with a safety factor such as is present in these BJ Tools:

The Type C Slip Elevator does *not* lift under the coupling, but carries the load on four extra-large slips which set automatically when the elevator contacts the coupling, or may be set by hand at any desired point. BJ Weldless Links are now furnished in 1¾" diameter by 36" or 48" in length—for tubing service.

BJ Rod Elevators have a one-piece heat treated body, and are equipped with both front and rear operating latches. Their perfect balance eliminates the possibility of kinked rods. The BJ "15" Rod Hook has ample strength for 15-ton loads due in part to the modern "locking arm" which closes and locks under load.

BJ Surestop Tubing Catchers do *not* hang up or set while running-in, but *do* set promptly (without damage to casing or catcher) in case the tubing string parts. When set with a BJ Anchor vertical movement of tubing is eliminated and the pump can take a full stroke, thereby increasing pump efficiency.

BJ Snapon Tubing Tongs completely encircle the tubing and are recommended for heavy duty service. The BJ Open End Tubing Tong is a fast, safe lightweight tong, very popular for ordinary service.

Many operators have requested us to make the BJ "20" Rod Hook, which is equipped with a relief spring and many other exclusive features of safety and convenience.

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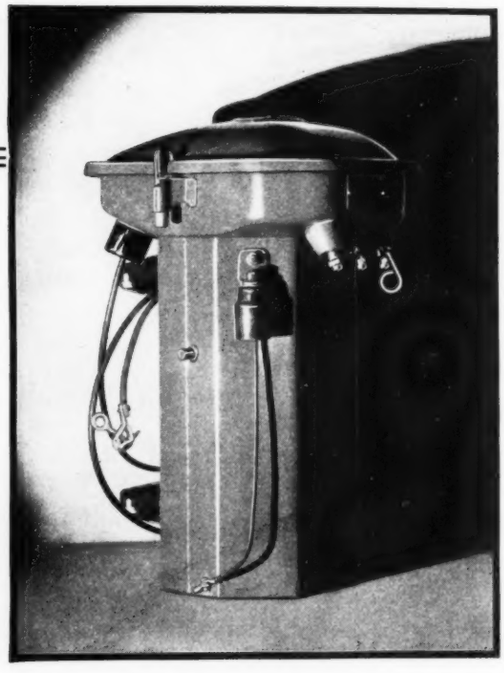
PRODUCTION TOOLS



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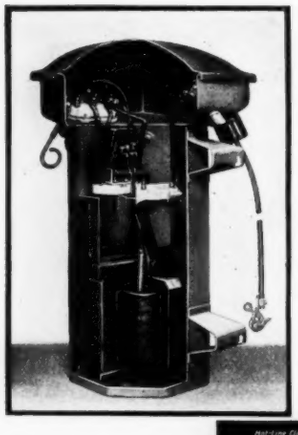

• Interior view of a 10 kv.-a. surge-proof transformer showing the arrangement of the circuit breaker with its operating handle.

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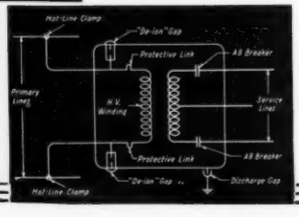


• This is the circuit diagram of the type CSP Westinghouse surge-proof distribution transformer.

Westinghouse

Drilling Against High Pressure in Burmah

High Gas Pressures Were Encountered in Drilling in Khaur Field, Attock District of the Punjab—The Means Used to Overcome Them Are Here Discribed by C. E. Keep and H. L. Ward.*

EVEN the shallowest beds in the Khaur field gave evidence of relatively high pressure, oil sands at 100 to 500 ft. from the surface yielding flowing production in the early stages of exploitation of the field.

Cable tool wells of 1,300 to 1,900 ft. in depth could not be controlled by columns of water, and the realisation gradually grew that the pressures to be dealt with considerably exceeded what would be experienced were they due to simple hydrostatic conditions. At 2,800 ft., wells drilled by the rotary system could not be controlled by mud fluid weighing 80 to 90 lb. per cu. ft. (sp. gr. 1.28 to 1.44), and one or two serious blow-outs occurred at this stage. Down to about 3,200 ft. sandstone predominates greatly over shale, and the holes down to this depth did not cave at all badly after the sudden release of pressure entailed by a "blow-out." Wells could be allowed to flow with several hundred feet of hole uncased, without being "beaned" at the surface, and yet there would be very little caving. Although the pressure was great, it did not afford a serious hindrance to the development of the field.

One well, 2,800 ft. in depth, blew out before the water string had been set; the conductor string gave way and the well flowed wild. Some months later, after the initial violence had died down, work was resumed. It was then found that the walls had stood up, and the hole remained open to bottom. The well was accordingly brought under control and cased without difficulty.

Below about 3,200 ft. the predominant formation is shale, and where much of this is exposed any sudden release of pressure caused caving to ensue, frequently to a dangerous extent.

There was a marked increase in rock pressure below the 3,500 ft. level, and it became necessary to equip the walls with master valves, blow-out preventers and mud discharge Christmas trees. In those cases where casing had been cemented directly above the high pressure sand, and little or no shale was exposed, it was a practical policy to take production without withdrawing the drill pipe from the hole. The pipe was raised a few stands from bottom, to bring the bit well up into the casing, and the well was allowed to flow either through the drill pipe or through the annulus between drill pipe and casing, back pressure being applied through beans on the flow lines, in order to combat the caving tendency of the exposed formation. When high pressures were encountered unexpectedly, often with several hundred feet of shale exposed, attempts to raise the drill pipe into the water string were foiled by the caving of the walls of the hole. Attempts to take production with the drill pipe in the hole generally resulted in sufficient loss of pressure to allow caving to commence. The drill pipe became frozen, and a difficult fishing job ensued.

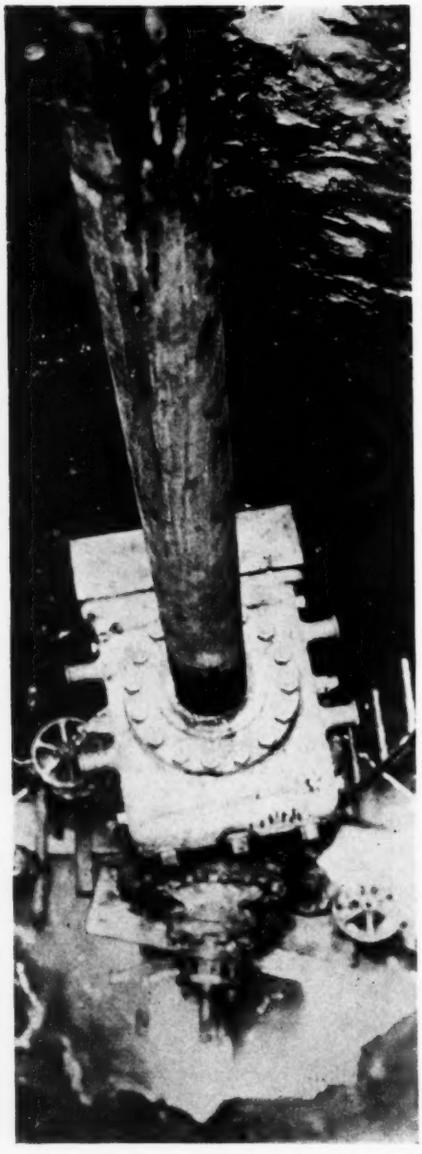
The mud fluid used at Khaur is made from a shale containing over 10 percent of ferric oxide, and has naturally a high specific gravity in relation to its viscosity. Mud weighing 95 lb. per cu. ft. (sp. gr. 1.52) can be used quite satisfactorily in the wells for drilling purposes, but this did not prove capable of controlling the pressures encountered. One well in which water had been struck at 4,400 ft. was filled with 95 lb./cu. ft. mud to the surface, and then closed in at the well head; pressure built up to 900 lb./sq. in. in fifteen minutes and was still rising when the valve was opened in order to prevent damage to the casing.

Barytes was then turned to as a possible means of overcoming the difficulty. Fluids of relatively high clay content and weighted with barytes to 120 to 130 lb. per cu. ft. would not control the pressures, and gradually more barytes and less clay was used until finally muds weighing as much as 150/160 lb. per cu. ft. were tried.

Mud fluids of such weights are almost pure barytes—water mixtures—and are deficient in certain desirable qualities as drilling muds, but they are by no means devoid of colloided matter. The upper dimensional limit of colloidals suspensoid

A view of the mud ditch and slush pit of the high pressure well.

* Extracts from a paper presented at a meeting of the Institution of Petroleum Technologists in London.



Cellar of the deep test with drilling riser in course of construction.

particles is 0.003 to 0.005 mm., and as 95 to 99 percent of the barytes is capable of passing a 300 mesh I.M.M. sieve, having an aperture width of 0.042 mm., much of the finer particles must come within the colloidal limit.

As relatively light muds of low viscosity proved incapable of overcoming the rock pressure, it was necessary to regard high specific gravity as the most desirable property, and muds approaching the maximum pumpable weight were used.

In some instances these heavy barytes muds did prove capable of controlling high pressures. In one case, a well 4,300 ft. deep that had previously blown out, and become plugged by cavings, was satisfactorily repaired, cased and brought on to production with the greatest ease, the barytes mud completely masking the presence of oil and gas until the mud was thinned down, when flowing commenced.

Such cases proved few and far between; in the majority barytes muds of the maximum weight proved incapable of controlling the wells. A mud weighing 144 lb./cu. ft. exerts a pressure of 1 lb. per sq. in. per foot length of a column, and it became apparent that the rock pressures being dealt with were of the order of 1 lb. per sq. in. per foot depth.

One great difficulty occurred in the use of barytes muds at Khaur. The brines encountered in the field are of very high salinity—up to 18 percent chlorides as NaCl—and contain a percentage of high valency metal radicles. The water therefore has a coagulating effect on the colloidal particles, and tends to break down the suspension. When a water was met under sufficient pressure to overcome the pressure exerted by the barytes mud, it would flow from the formation into the hole and mingle with the mud fluid; the mud would tend to coagulate and settle at the bottom of the hole and around the drill pipe. As a result, whenever the rotation was stopped, even for a few minutes (while making a new connection, for example), the precipitated mud and barytes would tend to freeze the drill pipe.

Treating the mud with the usual inorganic electrolytes (such as sodium silicate, soda ash, sodium tannate, lime, the salts of weak acids and strong bases, and the salts of strong acids and weak bases) failed to reduce materially the precipitating effect of brine contamination. Experimental work still continues, however, with some promise of success.

In consequence of the action of the brines on heavy muds, attention became diverted to the possibilities of pressure-drilling methods, in which a considerably lighter mud could be used and the balance of the pressure held by means of a form of stuffing box at the well head.

At depths of 3,500 to 5,000 ft. in the Khaur Field, fishtail bits average only 5 to 10 ft. before becoming dulled. Under such conditions pressure drilling would not be a practical policy, as an immense amount of time would be lost in snubbing, and the chances of accidental loss of pressure would be very great, in view of the frequency of bit-changing operations.

Most of the special types of bit tested showed little improvement over fishtails, and it was not until the autumn of 1931 that a bit was found capable of making much greater footage than fishtails. This was the Zublin bit. An average of 50 ft. per round trip can be made with this bit in the deep formations at Khaur, and it is primarily due to the advent of the Zublin that pressure-drilling methods have proved capable of application to Khaur conditions.

The superior footage of the Zublin bit is apparently due to the fact that it does not wobble about and cut a greatly oversize hole, as the fishtail undoubtedly did. It has been noticed at Khaur that much smaller amounts of cement are required to fill up the annular space behind casing in a Zublin drilled hole than in one drilled by fishtail bits; this is direct proof that the Zublin does not cut out cavities in the walls of the hole to the same extent as the fishtail.

At first, early in 1932 and about six months after the introduction of the Zublin bit to Khaur, pressure drilling was used only for the "drilling-in" of wells believed to be close to productive horizons. Equipment was not installed for snubbing the drill pipe into and out of the hole, as only one bit was required to drill the necessary distance ahead, but a chamber was provided for the bit and drill collar at the top of the casing, so that it would be possible to install, and use, snubbing equipment in case of necessity.

A number of wells have been completed at Khaur under conditions of pressure maintenance in this manner. The drilling string consists of 5-in. O.D. "Hydril," or 3½-in. or 2⅞-in. O.D. Sullivan, flush-joint drill pipe, carrying one or more back-pressure valves, and fitted with a 7⅝, 5⅝ or 3⅞-in. Zublin bit for drilling inside 8⅝, 6⅝ or 4¾-in. casing respectively. After the bit has been run to bottom, the stuffing box is packed. The hole is filled with fresh mud, and the drilling equipment is then tested by pump pressure, in preparation for drilling into the pressure zone. A pressure of 2,000 or 2,500 lb. per sq. in. is first applied by pumping down the drill pipe, with the mud discharge lines closed, and if this test is passed satisfactorily, the back-pressure valves are then tested by releasing the pressure on the mud pumps and drill pipe; there should be a slight drop in pressure on the stuffing box as the back-pressure valve closes and thereafter no further loss of pressure. Drilling then proceeds, with the circulating fluid passing out through beaned discharge lines at the relatively low pressure of about 500 lb./sq. in. As soon as gas is struck the control pressure is increased, by diverting the mud stream through smaller beans, until a condition of balance is obtained, the well neither making nor taking fluid, and the level in the slush pit remaining constant. On reaching the predetermined completion depth, drilling is stopped and the bit raised up a few stands, the pumps running slowly mean-

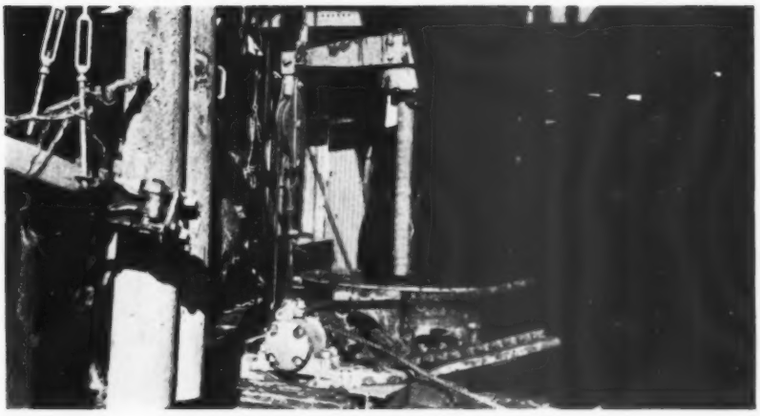
time to keep the full pressure on the well. Thereafter the well can be brought on to production, through the annular space between the drill pipe and casing, by opening one or more bean lines and shutting down the pumps.

When a well is completed under conditions of pressure maintenance, it is always a difficult problem to decide at what rate production may be withdrawn. Gradual loss of pressure must accompany the removal of fluid, and only local experience can guide in deciding what rate of pressure decline may be allowed without serious caving occurring.

As an illustration of the pressures that require to be dealt with at Khaur, it may be mentioned that on one occasion a well suddenly plugged the bean lines, just at the time when it was being allowed to come on to production, and in a few minutes had built up a pressure of 2,750 lb./sq. in. on the well head. The pressure was still rising when one of the lines was unplugged, and it is probable that a disastrous blow-out was narrowly averted, as the casing consisted of a string of Grade C. pipe only lightly cemented.

After several wells had been completed by the use of flush-joint drill pipe, it occasionally happened that the high-pressure zone was not met where anticipated, and deeper drilling was necessary. Several thick beds of shale would be exposed below the shoe of the water string, and unless they could be cased off before the well was allowed to commence flowing, caving would occur to a serious extent. Perforated strings of casing cannot be run into a well while the pressure is being controlled through well-head stuffing boxes, as the fluid would be free to escape from the well through the perforations of the first few joints. It was necessary to provide some means whereby the drilling string, or a part thereof, could be left in the hole to serve as casing and prevent the formation caving.

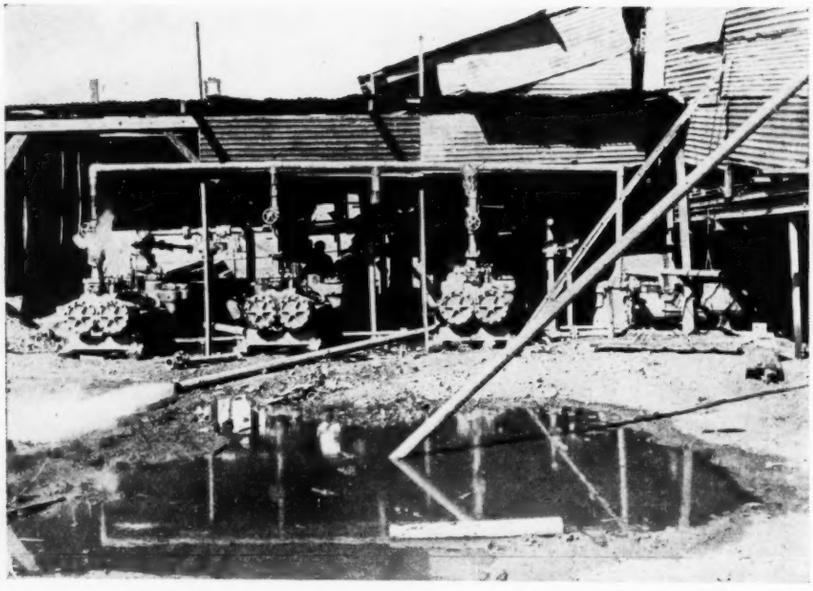
Accordingly, Mr. Ward devised a method whereby a perforated casing liner can be used as part of the drilling string and can later be "backed off" and left in the well to keep the hole open. In order that the mud flush may be directed down to the eyes of the bit during the process of drilling, and not be able to escape through the perforations of the casing section, a wash pipe of 1¼-in. tubing is run throughout the length of the casing, firmly sealed off to the drill pipe at the top and to the drill collar at the bottom. The upper seal is provided for by connecting the wash pipe into the upper half of the safety joint which connects the casing to the drill pipe, and the lower seal is effected by furnishing the top of the drill collar with a conical recess into which a special tapered coup-



Snubbing equipment on the deep test in actual use: a stand of drill pipe has just been unscrewed.

The auxiliary draw works used for snubbing is on the left of the picture just behind the 20 in. casing protruding from the Kelly rat hole.

Arrangement of snubbing bar and wire tackle for the deep test.



A view of some of the pumps used for the deep test.

ling run on the bottom of the wash pipe may sit.

As an illustration of the method used, let us assume that a well cemented in 8⅝-in. casing at 4,550 ft. has been deepened to 4,600 ft., under pressure control arrangements as previously described, but has failed to pick up the expected high pressure production, and is to be drilled ahead prospecting for another possible productive sand. In such a case, the drilling string would be composed of the following items: (1) A 7⅝-in. Zublin bit; (2) a short drill collar, carrying near its base a back-pressure valve, and shaped at the top so as to form a tapered and ground seat; (3) about 200 ft. of 6⅝-in. casing perforated suitably near the base; (4) a safety joint, from the upper half of which would be suspended about 200 ft. of 1¼-in. tubing; (5) a back-pressure valve; and (6) 3½ or 5-in. flush-joint drill pipe extending to the surface. The bit, drill collar, casing, and the lower half of the safety joint are connected together and run in the usual manner; then the 1¼-in. wash pipe, fitted with a tapered and ground coupling, is run inside the 6⅝-in. casing until the coupling seats in the top of the drill collar. The uppermost joint of the tubing is now paint marked about 3 in. above the level of the top of the lower half of the safety joint; it is then taken out from the well, cut off at the mark and threaded and welded to the upper half of the safety joint. The tubing is then re-connected at the well and lowered so that the bottom seats in the conical recess in the drill collar again. This leaves the upper half of the safety joint about 1 in. above the lower half. The two are forced together and screw up, thereby putting the tubing in compression and forcing the bottom coupling well home into the seat in the drill collar. The drilling string is then completed by addition of the back-pressure valve and the flush-joint drill pipe. Drilling proceeds, the mud flush passing down from the drill pipe and through the 1¼-in. tubing to the eyes of the bit. When it is required to stop the well and take production, the drill pipe is rotated in a counter-clockwise direction to open the safety joint, and detach the casing liner from the drilling string. The flush-joint drill pipe may then be pulled up several hundred feet, carrying with it the 1¼-in. washpipe, and flowing production taken through the perforations in the liner and thence between the drill pipe and the casing.

Vernier type weight indicators have been found of great value in indicating whether or not the liners have been safely backed off, particularly when only a few joints are in use.

The wash-pipe-liner method of drilling into zones of high pressure has been of great value at Khaur. It affords a ready method of drilling and casing wells in one operation, without release of pressure. Flowing production can be taken from the well until the pressure is relieved to such an extent as to allow of the casing-head being opened. In one case a liner of 4¾-in. casing nearly 900 ft. in length was used in a well lined with 6⅝-in. casing, and very fair footage was obtained.

There are, of course, obvious objectionable features to the method. For example, it is not possible to make a round trip with the drilling string under pressure control; once high pressure conditions have been struck the only further progress that can be made depends on the condition of the bit. Again, it would not be possible to pull the 1¼-in. tubing from the hole, under pressure control, without a complicated system of stuffing boxes. A modification of the drill-pipe back-pressure valve, so as to allow of its being opened or closed at will, might effect a great improvement in the flowing efficiency of the well during the production stage; the flow could be taken through the 1¼-in. tubing, and the drill pipe, instead of through the annular space between drill pipe and casing.

When drilling under pressure at Khaur the control pressure is increased to the extent necessary to prevent fluid entering the well from the formation. Wells at depths of 4,800 to 5,300 ft. usually require a control pressure of 2,000 to 2,300 lb. per sq. in., imposed on a column of mud fluid weighing 85 to 95 lb. per cu. ft., in order that this condition may be satisfied.

Abraham and Singleton have shown that closed-in well-head pressure may considerably exceed the difference between the rock pressure and the pressure exerted by the mud column, owing to the fact that bubbles of gas in the mud will tend to rise to the top of the well. Usually fluid can only be driven back into the formation with difficulty, if at all, so that the gas bubbles have little opportunity for expansion, and remain under relatively high pressure.

It is important, therefore, to establish the fact that the calculated rock pressures of Khaur are based not on closed-in well-head pressures, but upon the control pressure which it is necessary to hold on the circulating fluid in order to prevent ingress of fluid from the formation. Under these circumstances the sum of control pressure and mud-column pressure is clearly equal to the rock pressure.

There have been many instances in the field of control pressure plus mud-column pressure equalling or exceeding 5,000 lb. per sq. in.

In the development of the field, high-pressure oil and gas sands tapped by wells drilled under conditions of pressure maintenance, in the manner already described, could be produced, by natural flow, under controlled back pressure, until the pressure declined. A high-pressure water sand was, however, met in a number of wells, at depths corresponding to a crestal level of 5,100 ft. below the surface. This sand generally carried a large volume of water except in the western portion of the field, where it had yielded little water; two wells deepened through the sand in this part of

the field had encountered a second water-bearing sand, termed the 5,300 ft. sand. Before exploring the underlying rocks it was therefore necessary to drill through the 5,100 and 5,300 ft. sands. Two alternatives presented themselves: firstly, to drill through the sands against the full rock pressure, or, secondly, to drill into the water sands at selected points (old small diameter wells) and allow the water to flow, until such time as the pressure would become dissipated to a more easily controlled level.

A certain amount of water had been produced from two or three wells in the 5,100 ft. sand, with the object of relieving the pressure, when it was decided to proceed with the deep testing of the field. It is with the drilling of the selected well through the 5,100 and 5,300 ft. horizons that this paper now deals.

The well had been cemented directly over the 5,100 ft. sand in 8⅝-in. 38 lb./ft. A.P.I. casing at 5,206 ft. Although the casing was only Grade C. material the cement job had been a heavy one, 850 cwt. of cement being used and cement returns being obtained at the surface. It was, therefore, considered safe to use pressure drilling methods inside the string, and this in fact proved to be so.

The hole was carried from 5,214 ft. to 5,693 ft. with 7⅝-in. Zublin bits, and a string of 7-in. O.D. Hydril flush-joint casing then cemented with the shoe at 5,685 ft. It is this stage of the progress of the well that is now discussed.

The cellar was deepened to 34-ft.—measured from the base of the derrick floor sills—and the drilling riser built up, in the following order, reading upwards from the floor of the cellar:—

(*a*) A Kerotest mud cross.
(*b*) A Shaffer control gate fitted with blind rams.
(*c*) A Kerotest master valve.
(*d*) A Shaffer control gate fitted with 5-in. drill pipe rams.
(*e*) A 15-ft. length of 8⅝-in. casing to serve as "gun barrel," or chamber for drill collar and bit.
(*f*) A Shaffer control gate fitted with 5-in. drill pipe rams.
(*g*) A Kerotest mud cross.
(*h*) A Doheny Stone Hydril 5-in. Drilling Head, complete with hydraulic bag packer fitted below the drilling packer.

Both the Kerotest crosses were connected to the mud outlet lines and also to the mud pump discharge manifold, so that either could be used for outgoing or for ingoing mud.

The outgoing mud lines passed from the crosses to special traps, installed for the purpose of removing rock fragments, and thence to a battery of beans of both the adjustable and the drilled plug type. The traps were constructed of vertical 8⅝-in. pipes in which were suspended perforated 3-in. pipes, the mud entering the annulus between the pipes and passing out through the 3-in. pipe. In this way the coarse fragments of formation cuttings were filtered out from the mud before it passed to the beans; plugging of the beans was prevented, and formation samples were recovered periodically by back flushing the traps.

Before deepening commenced it was decided to make every attempt to control the well with ordinary, unweighted, shale mud, in order to avoid the dangers attending the contamination of heavy barytes muds by salt water. As it proved possible to control the rock pressure with ordinary mud, using a high well-head pressure, it was not necessary to use laden mud. The well was therefore drilled with shale mud weighing about 90 lb. per cu. ft., throughout the interval 5,214 to 5,693 ft.

The mud pumps used were of the conventional steam-driven type, 14-in. steam cylinder, 7¼-in. fluid cylinder and 14-in. stroke, and were used compounded together in series, the first stage, or pick-up, pump being fitted with a low-pressure mud end and the others with 3,000 lb./sq. in. fluid ends. At first, drilling at 5,214 to 5,478 ft., a bean pressure of 1,800 lb./sq. in. was required to control the well. To obtain this, three pumps were compounded in series, the first fitted with 6-in. liners in the mud cylinders, the second and third with 5-in. dia. liners. Steam was furnished at 200 lb./sq. in. at the boilers, and the pump discharge pressure under these conditions was about 2,250 lb./sq. in. Later on, at 5,478 to 5,693 ft. the control pressure had to be maintained at 2,000 lb./sq. in., and four pumps were then compounded together, equipped with 6-in. liners, and giving a pump pressure of 2,700 lb./sq. in. At all times there was one spare pump to serve as a standby, there being a total of four pumps at first and later five pumps in the battery.

The steam supply to the mud pumps could be controlled by a valve on the derrick floor close to the hand of the driller.

A high-pressure steam-driven water pump—20-in. steam cylinder, 3½-in. water cylinder, 12-in. stroke—was also connected up, being used for delivering water to the hydraulic bag packer on the Doheny Stone head, or to the mud pump manifold and drill pipe. In connection with the latter service, it will be realised that when making a round trip with drill pipe under pressure drilling conditions, the string is full of fluid and cannot be pulled "dry." To overcome the disadvantages of having mud ejected from the drill pipe as each stand was disconnected, a measured volume of water was pumped into the drill pipe periodically to displace the mud from a certain number of stands. In this way the derrick floor was kept clean and the top packing rubbers did not get covered with mud when the pipe was being pulled; the drilling riser and cellar were also kept free from mud.

The drill pipe used for the deepening of the well consisted of 5-in. O.D. Hydril flush-joint drill pipe Grade D. 20.5 lb./ft., supplied in 30-ft. lengths with box connections at each end and equipped with a tool joint per length. The pipe was handled in stands of three joints, a uniform length of 90 ft. per stand. As the standard type of rotary table was in use it was necessary to devise a satisfactory method of rotating the drill pipe. This problem was solved by taking a length of 8⅝-in. casing 35 ft. long and welding it to two special bushings, the lower bushing fitting into the rotary table in place of the usual Kelly bushing, and the upper bushing made to take a standard 4-in. square Kelly as a sliding fit; with this pipe set in the rotary table the drive was transmitted from the table, through the length of the 8⅝-inch pipe, to the upper bushing. The flush-joint drill pipe was screwed to a 4-in. square Kelly and this lowered into the upper bushing of the 8⅝-in. pipe, so that the string could be rotated in the normal manner, but with the Kelly bushing some 35 ft. above the level of the table. As the square Kelly was 30 ft. long it could be drilled down the full length inside the 8⅝-in. pipe without interfering in any way with the installation of the drilling riser, which was of course only suitable for the 5-inch flush-joint pipe, and was installed a few feet below the derrick floor. After 30-ft. of hole had been made, another single joint of drill pipe would be added to the string and drilling resumed.

For snubbing the drill pipe into or out of the hole a snubbing bar and a stationary hold down were manufactured at the field. The equipment was operated by wire lines passing over single-sheave blocks suspended from either end of the snubbing bar, and double-sheave blocks bolted to the stationary hold down, so that a three-line pull could be given. A second draw-works, of light type, was installed on the pump side of the derrick floor for operating the snubbing bar; this draw-works served to pull the snubbing bar downwards, while the main draw works was employed to keep a tight hold on the drill pipe and would have prevented it falling back down the hole had there been an accidental release of pressure from the well. The snubbing bar itself was suspended in the rig from wire lines passing over a pully carried by the sand line, and was raised or lowered by the operation of the sand reel whenever a new hold had to be taken. It will be noted that three hoists were in use—

namely, the main draw-works, used for feeding the bit in the process of drilling and for exerting an upward pull on the drill pipe during round trips, the auxiliary draw-works, used for pulling downwards on the snubbing bar during snubbing operations, and the sand reel, used for raising or lowering the snubbing bar when it was required to take a fresh hold of the pipe.

Using drill pipe of 5-in. diam. and weighing 20.5 lb./ft., approximately 1 ft. of pipe has to be snubbed for each lb. per sq. in. pressure held on the casing head. Accordingly, under the pressure conditions ruling, it was necessary to snub two to three thousand feet of the drill pipe in and out of the hole at all round trips. Even in such an extreme case as this, the snubbing effort that is required is not great, and it is possible to handle the pipe rapidly with safety. The minimum ultimate strength of 1-in. diam. Grade J. 6/19 wire line under A.P.I. rating is 69,000 lb. The maximum load was only about 50,000 lb. and six lines were used in snubbing—three on each side of the bar—so that a safety factor of 8 was allowed. When snubbing against the maximum load three hitches were taken for each stand of drill pipe, that is the snubbing bar was allowed to travel a distance of 30 ft. before a new hold was taken; when the load was lighter a stand of pipe was snubbed in two hitches, the bar being allowed to travel 45 ft. before a new hold was taken.

It was obviously necessary to be in a position to close the well in very rapidly, in case of signs of any leak in the control equipment. For this purpose mechanical means were rigged up for operating the more important well-head valves.

A countershaft was set up below the derrick floor, fitted at one end with a cat-head and at the other with two sprocket wheels. The shaft was driven from the cat-head by means of a rope which could be thrown on to the cat-head of the auxiliary draw-works at any moment, and the sprocket wheels could be connected by chain to similar wheels fitted to the spindles of the master valve and one of the drill-pipe ram gates.

Normally, when the drill pipe was in the hole, and extending below the master valve, the chain from the countershaft sprocket was connected to the drill-pipe ram gate. This gate could then be closed at a moment's notice by spinning the rope on the cat-head of the auxiliary draw-works. Once the bit had been pulled up into the chamber, the master valve could be similarly operated by chain drive from the countershaft.

Subsequently arrangements have been made for the operation of the drill-pipe ram gate by means of an electric motor.

Mud-weight scales were set up in the slush pit and in the mud ditch to indicate and record the weight of the mud fluid at the pump suction and at the outlet from the well.

The pump discharge pressure and the control pressure held on the mud outlet lines from the well were indicated and recorded by means of the usual Martin Decker equipment, embodying special diaphragms and vibration dampers to prevent damage to the gauges either by intrusion of mud or by the frequency of the pulsations. A comparison of the daily charts obtained from these mud-pressure gauges was of immense value in checking up the operations at the well over a period.

As has been previously noted, the 8⅝-in. casing had been cemented directly over the 5,100 ft. sand, at a depth of 5,206 ft. After the cement left inside the hole had been cleaned out the well commenced to show water and it became necessary to increase the control pressure gradually until the flow was killed. At 5,215 ft. mud fluid weighing 88 lb./cu. ft. was being circulated against a pressure on the beans of 2,000 lb./sq. in.; it appeared that there was no gain in level in the slush pit and that the rock pressure was approximately balanced. The rig had to be shut down a short while for repairs and the closed-in pressure then rose slowly to 2,150 lb., and stayed at that level for half an hour until work was recommenced. It is probable that this rise in well-head pressure, from 2,000 to 2,150 lb./sq. in., was due to the effect of gas bubbles rising through the mud.

As drilling proceeded, it was noted that the well alternately yielded water from the formation, or extracted water from the mud fluid, dependent on whether the control pressure was allowed to fall or rise respectively. If the pressure fell, water would enter from the formation and dilute the mud, but what was much more unusual was the fact that if the bean pressure were increased appreciably the mud returns would shrink in volume and show increased weight and viscosity; there was no doubt that the free water was being squeezed out of the mud fluid and filtered into the formation. If this process were allowed to go on unchecked, the mud would become more and more viscous until the limit of "pumpability" was approached; if the bean pressure were reduced water would pass back from the formation and the mud would "thin up."

On one occasion, after a round trip at 5,447 ft., new mud weighing 94 lb./cu. ft. was pumped into the well against a bean pressure of 2,100 lb./sq. in. The weight of the return mud rose gradually from 94 to 96 and finally to 98 lb. per cu. ft. Lowering of the bean pressure and the addition of lighter mud allowed the previous conditions of balance to be re-obtained.

From 5,215 to 5,478 ft., the control pressure had to be kept at 1,800 lb./sq. in., using 90 lb./cu. ft. mud fluid, in order to prevent the well yielding water. The rock pressure at 5,215 ft. may therefore be calculated as 5,060 lb./sq. in.

Later this formation apparently became sealed off, as after the 5,300 ft. sand had been struck, at 5,478 ft., it became necessary to use a still higher control pressure, and this proved possible without loss of water from the mud. From 5,478 to 5,693 ft. the control pressure had to be maintained at 2,000 lb./sq. in., with 90 lb./cu. ft. mud, to prevent a gain in volume of the circulating fluid. The rock pressure at 5,478 ft. appears therefore to be about 5,420 lb./sq. in.

On reaching a depth of 5,693 ft. it was decided to cement casing in order to exclude the 5,100 and 5,300 ft. sands. For this purpose a string of 7-in. O.D. flush-joint Hydril seamless casing, 30 lb./ft., Grade D., had been obtained.

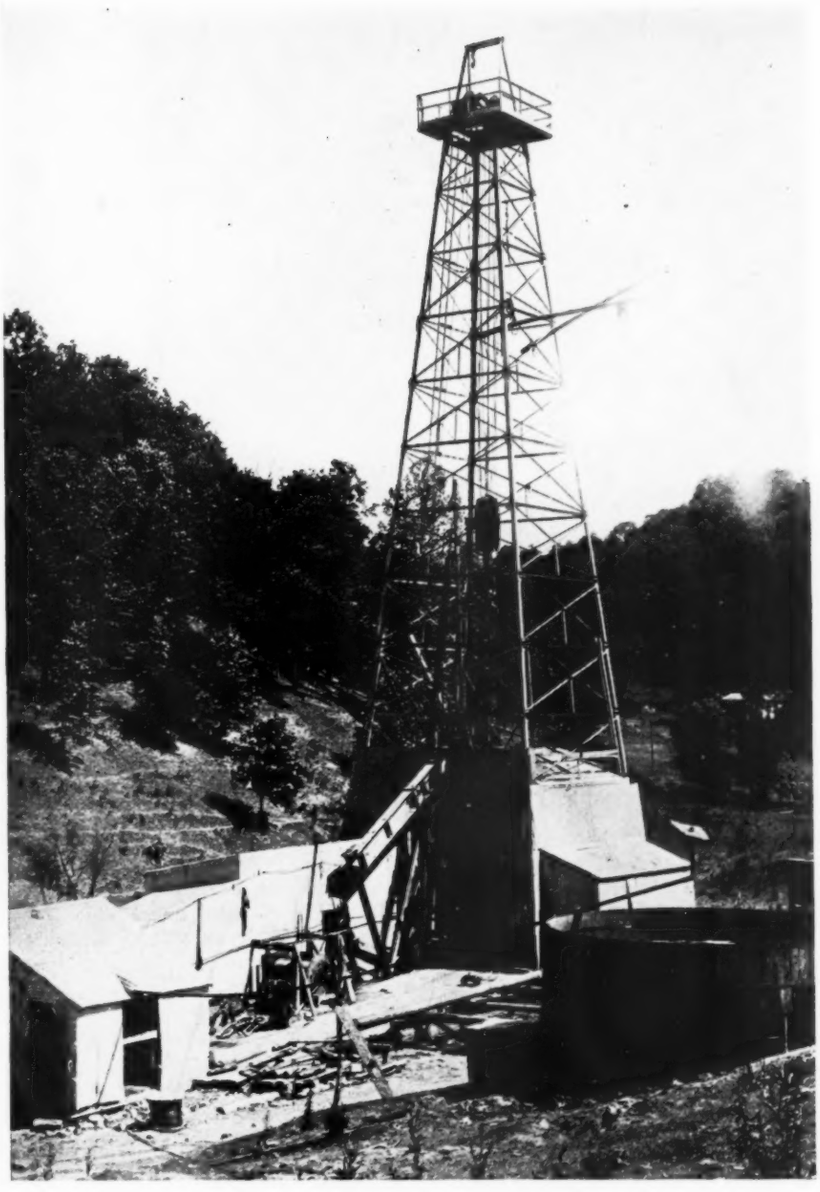
A Seamark blow-out preventer, comprising two single static heads, suitable for 8⅝-in. casing, and complete with hydraulic intensifier was available at the field.

The top Shaffer gate of the drilling riser was fitted with rams to close against the 7-in. casing, and the Doheny Stone Drilling Head was replaced by the Seamark blow-out preventer fitted with 7-in. packers.

The snubbing equipment for running the casing was somewhat heavier than that used for the drill pipe, but was operated in a similar manner, by wire lines leading from the auxiliary draw-works. The running of the casing was done under a bean pressure of 2,000 to 2,400 lb./sq. in., but proceeded as smoothly as an ordinary casing job. It was not until a depth of over 3,500 ft. was reached that the casing in the hole balanced the well pressure. The snubbing equipment had to be kept in use thereafter to force the pipe through the blow-out preventer, and it was only after 4,190 ft. had been run that snubbing was no longer necessary. The casing was finally carried to a point 8 ft. off bottom and there cemented.

Two hundred and thirty-eight sacks of cement (112 lb. each) were used in the cementation.

After standing 14 days, the 7-in. casing was opened at the head and the cement job tested and found to be successful, the water being sealed off both from the hole and from the annular space between strings. The well had been carried through the high pressure waters and these were now successfully excluded.



Deepest Cable Tool Well

WHILE the rotary drill has been used in the world's deepest wells it should not be overlooked that at least one well has been carried to a depth of nearly 10,000 ft. by the cable tool method which was the earlier and most extensively employed method of drilling. This well was drilled by the United Fuel Gas Company at Frozen Camp, W. Va., and was known on the company's records as No. 4053.

This well was spudded in early in 1930 and drilling continued with some slight interruptions for more than two years. Oil, gas and water all were encountered in the course of the work. Although finally abandoned as unproductive at a depth of 9,270 ft. the fact that it was carried to a distance that had seldom been equaled up to that time with methods not considered to be adapted to deep drilling testifies to the skill of the engineers and drilling crew and the excellence of their equipment.

Casing Log

Feet	Size	Wt. per Ft.	Total Wt. lbs.
624	18⅝	87.5	54,000
1,001	16	84.	84,084
1,946	13⅜	68.	132,328
4,119	10¾	51.	210,069
5,221	8⅝	38.	198,398
6,886	6⅝	26.	192,803
			872,287

These heavy strings were not floated but were run without difficulty and in remarkably quick time. Power for the drilling was furnished by a Franklin valveless 2-cylinder engine with countershaft. Most of the equipment used was built by the Parkersburg Rig and Reel Company. The 5-sheave casing block weighing 7,200 lbs. with the casing line hooks and blocks were supplied by Oil Well Supply Co.

One piece of equipment that proved its value in the drilling of this well has been adopted on most of the deep wells since drilled. This was the Hydromatic brake developed by the Parkersburg Rig and Reel Co.

This brake operates on a principle different from any previously applied in the oil industry. Its resistance is secured by fluid friction occurring between the interior surfaces of the enclosed housing and the fluid circulating through it. There is no mechanical or dry friction nor are there any wearing surfaces to be replaced as in the case of mechanical brakes. It retards the speed of the hoist while lowering the load in a manner similar to that in which the speed of a boat is retarded by a bucket dragging behind it.

The Hydromatic does not replace mechanical brakes but is used in conjunction with them. As its resistance is dependent upon motion, it absorbs the energy developed, and controls the speed of the descending load, up to the instant of stop. The mechanical brakes are used actually to stop and hold the load and for other operations, such as feeding, normally associated with drilling operations.

For any speed increase its resistance increases more rapidly than the load so that it acts as a governor and prevents runaways. The resistance may be regulated quickly and positively to meet any requirements as to load and speed. Its use materially reduces the shocks and jars usually prevalent during drilling activities. The heavy loads associated with deep drilling are handled as easily and safely as those attending operations at more shallow depths. Being adaptable to any type of draw works it may properly be classed as one of the important contributions toward drilling to record breaking depths.

Evolution in Pumping Practice

Economic Necessity Has Caused More Attention to Cost Factors in Pumping That Were Formerly Overlooked, Resulting in Greater Efficiency.

By W. G. Taylor
Industrial Engineering Dept.
General Electric Company

A TOUR through the oil fields, especially where the wells have ceased flowing, or are expected to do so soon, discloses a decidedly healthy effect which has been produced by the disturbed conditions in the industry during the past few years. This is more noticeable now to even the casual observer, although the powerful incentive behind it has been working for a long time. Reference is made to the subordination of operating methods, and particularly of mechanical pumping methods, to economy of operation in the production of oil.

The old "standard" pumping rig—nothing more than a cable-tool drilling rig—which twenty years ago was almost universally used for individual well pumping in this country, is being displaced to an extent which presages its eventual relegation to the list of relics of a by-gone age. With this rig other things are passing out of the picture, all of them no longer able to maintain their standing in the industry, because they are losing their underlying support-habit. Habit of thought has let many a dollar slip out of reach of the operator and ultimately of the stockholder; for example, the former habit of considering oil as free fuel. The fallacy of this habit was one of the first to be recognized. Habit of action changes more slowly, and is often accompanied by fear of the outcome.

The habit of pumping wells with the old standard rig created the demand that improved mechanical equipment should maintain the habitual method of operation. This imposed a serious handicap on improvement, because the old rig was cleverly laid out for maximum convenience, and is hard to beat in that respect. The electrical manufacturers did succeed in meeting such a demand by designing a motor to replace other forms of power equipment for well pumping without changing old established production methods, but many a design of pumping rig has been scrapped in the attempt to improve upon the old rig under this handicap.

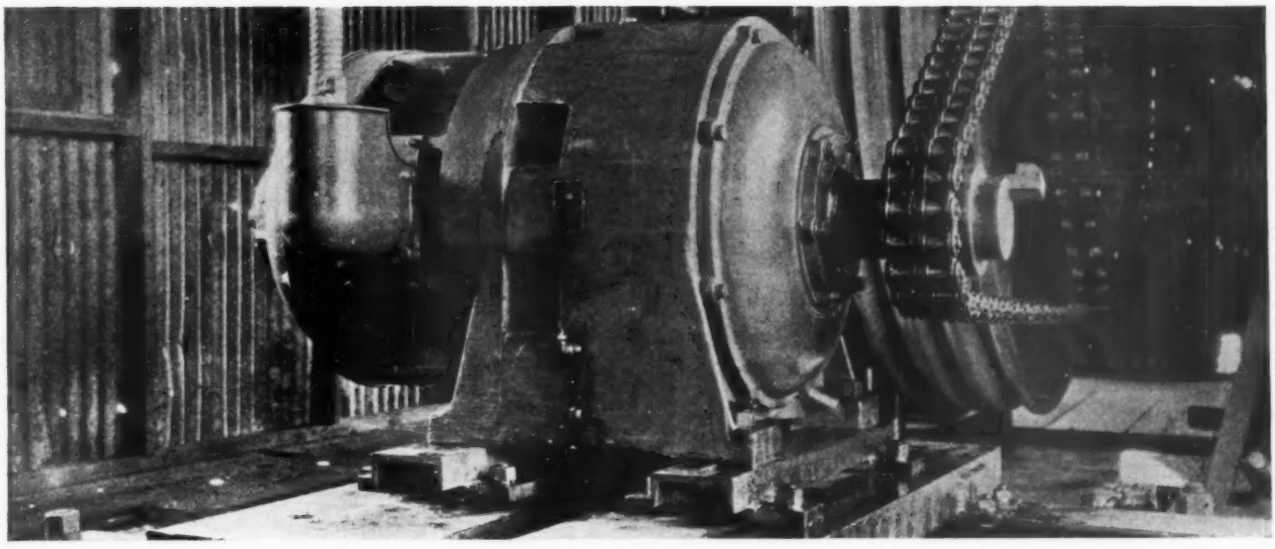
A 100 H.P. motor-driven mobile production hoist equipment developed in California for servicing wells operated by small pumping motors.

The major improvements of recent years, started by operators whose boldness was largely impelled by a necessity of finding a means of survival, are fundamentally changes in methods, making possible the use of equipment which produces more economical operation. Overproduction and proration have of course been important influences which still prevail, but when these are gone the methods of operating producing wells will continue to be very different from those of twenty years ago.

It would be difficult to determine what early changes led to others, but it is likely that the owners of small producers, or stripper wells, were among the first to feel the economic urge to do something. When the falling price of oil or the rising cost of operation made it necessary to ferret out a profit or abandon operations, habit took a back seat. Knowing that friction, repairs and low volumetric pump efficiency were taking a heavy toll from possible profits, the owners of stripper wells set out to improve these conditions, and the logical move was to reduce the pumping speed. It was surprising to find that the production usually did not suffer, and the benefits gained proved to be in almost inverse ratio to the speed reduction. Pump, rod and rig maintenance were nearly eliminated, and power consumption reduced as much as 80 percent. Thus slow-motion pumping developed from an experiment to a recognized new practice.

Of course the old standard rig layout had to be changed to pump at low speed, for as much as 60 to 90 percent reduction in the original pumping speed was made, bringing it down to only a few strokes per minute, often less than five. The power required was reduced in almost a direct ratio; and it was found that there was little advantage in varying the speed, once the best speed had been determined.

Only electric drive fitted in readily with this change, to produce the maximum benefits in the form of high economy and flexibility of layout. A squirrel-cage induction motor of small capacity was required to suit these new conditions, and high motor speed gave the best efficiency. To reduce this speed to the



A triple-rated gear-motor, 40/28/16 H. P., 87 RPM, driving the crankshaft of a beam-pumping rig in the deep Oklahoma City field.

low value required at the rig was a mechanical problem which was met by various combinations of gears, sprockets and chains, but the real solution was the gear-motor. This is a motor combined with a built-in reduction gear, single or double, and is a highly compact and efficient unit which can be connected directly to the crankshaft by chain drive. The gear-motor has made the problem of slow-motion pumping a simple one.

The gear-motor is likewise exceptionally well suited to the needs of a long-stroke pumping rig, and has been used for this purpose for several years. As the speed of such a rig in strokes per minute is usually relatively low, the gear-motor presents all the advantages for this drive that it has for slow-motion pumping.

One change leads to another and a new habit, justified by sound practice, is formed. The elimination of belts and pulleys, and the reduction in foundations and in size of motor house resulting from the compactness and simplicity of the gear-motor, all leading directly to lower expenses and better operation, have attracted attention to this unit for pumping wells above the stripper class and out of the slow-motion class—in other words, heavy wells at full speed. A number of gear-motors have been giving eminently successful service under such conditions in the deep Oklahoma City field.

Sucker rods place a serious limitation on deep well pumping, and at high pumping speeds their maintenance is a considerable item of expense. If they could be eliminated without introducing other limitations or troublesome factors, it would be a notable accomplishment. A step in this direction is the submergible motor-driven centrifugal pumping unit which is lowered into the well, several of which are in operation in the Mid-Continent fields. This is a very decided departure from conventional pumping practice, and although economic considerations apparently limit the application to wells which can produce large volumes of liquid, this method is an example of what can be done by electric-motor drive.

The new fields of recent years show the most evidence of the fact that habit no longer rules the operator in his selection of mechanical pumping equipment. It has been said that the vast East Texas field will be the proving ground for all new equipment of the modern trend, and an inspection of the field even now shows that there is no doubt of this. Already, with only a small proportion of the thousands of wells there equipped for pumping, the variety of equipment installed is probably unprecedented. Much of it has already proven its worth and the pumping practice it represents is extending to older fields where the resulting economies justify it.

Large volume production in the United States has been and still is restricted by proration. This has resulted in a new technique in well operation which has never before been practiced and new equipment has been devised to meet it. A wide variety of pumping loads must be anticipated on every prorated well, and provision may be desired for operating a production hoist installed at the well.

This at first seemed like a difficult situation to meet with power equipment which would operate efficiently under all conditions, but the double-rated electric motor which was already available, and the triple-rated motor which was soon devised for the purpose, solved the problem in a highly successful manner and provided all the flexibility needed. These motors are principally of the squirrel-cage type, requiring only simple control devices. The windings are so tapped that connections for any one of the three ratings are made in a moment by throwing or plugging-in one of three switches. The motor runs at practically the same speed on all three ratings. These ratings have been standardized in the ratio of 10, 7 and 4, for example 25/17/10 h.p., the highest rating always being a normally standard one.

The triple-rated motor is selected with a low rating of suitable capacity to pump the well when it is first put on the beam, the load then usually being light due to the fact that about all the well needs is a little agitation to make it produce. As the gas pressure subsides and the fluid level in the hole goes down, the pumping load will increase, which may eventually require the intermediate rating of the motor to handle it successfully. Another factor which would increase the load would be an increase in allowable production, which on a 24-hour basis would require faster pumping. The intermediate or perhaps the high rating might be necessary eventually at full production before the inevitable decline in "potential" brought the production rate down again, and with it the load on the motor.

The taking of potential on a heavy pumping well operating under proration is likely to impose a very heavy load on

A California outdoor installation of a 25 H.P. splash-proof squirrel-cage induction motor for oil-well pumping.

the equipment and require the full capacity of the high rating of the triple-rated motor. In fact, this can conceivably be the condition which will determine the size of motor necessary on some wells.

The wide range in rated capacity available from a triple-rated motor enables a single size to be used to good advantage for all wells on a lease even though they vary widely in power requirements. The motors, thus being duplicates, are interchangeable, and require only one stock of renewable parts. This makes the operation of the lease very flexible when old wells are abandoned and new ones brought in, and the investment in warehouse stock is kept at a minimum.

The advantage of a triple-rated motor over one with a single rating lies in the better efficiency and power factor which the lower ratings give on the light loads. Improved efficiency reduces the power bill and thus makes a direct saving in operating expenses. Improved power factor likewise will reduce the power bill and save money where the power contract allows a bonus for high power factor, as is often the case. These improvements also reduce the losses in the power lines.

The accompanying curves show the relative efficiencies and power factors on a triple-rated motor with ratings of 25, 17 and 10 h.p. The efficiency curves make it evident that for loads on this motor below 13 h.p. the two lower ratings are decidedly superior, which means that in the long run they will make a saving in power consumption which will more than justify the very small additional cost of the triple-rated motor over that of an ordinary motor.

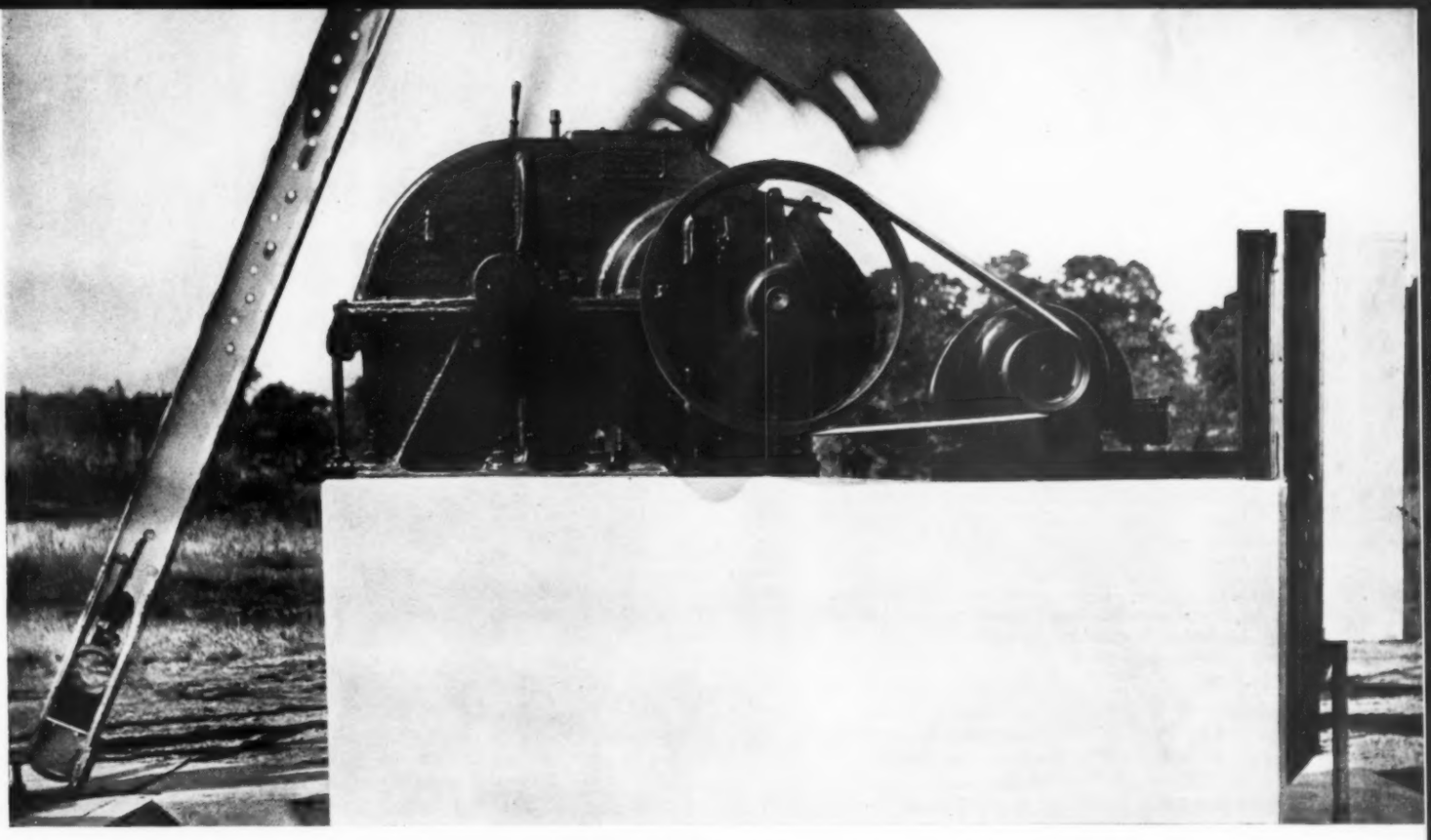
The gain in power factor on the lower ratings for any loads which those ratings are capable of handling is very pronounced, as the power factor curves plainly show, and it is easy to interpret what this means in terms of a bonus obtained which reduces the power bills. The saving in line losses and improvement in voltage regulation is likewise pronounced.

One fundamental change in the operation of producing wells underlies the various changes in practice which have been described. No longer is it universally required that the engine or motor perform all the functions of pumping and pulling, although there are still many places where good judgment dictates that this should be done. It is recognized, however, that such a combination is at best only a compromise in which the highest economy cannot be realized.

The minimum investment and highest efficiency in the use of power is obtained by pumping the wells by motors designed and selected in size only for pumping, and by using a tractor or a portable motor-driven hoist for all pulling operations. Of course this cannot always be done where the terrain is broken or mountainous, and it is not the most expedient method on a small outlying lease where the cost of a portable hoisting equipment is not justified by the work it would have to do. In such cases the two-speed oil-well motor is best suited for the work.

In general, however, the fact that most of the running time at a well is spent in pumping it, and the pulling is done intermittently and usually only occasionally, the best engineering practice calls for a small highly efficient pumping motor, and a larger motor designed for hoisting. These characteristics are incompatible in the design of a single motor, and both efficiency and power factor must be sacrificed in such a motor. This applies even to a triple-rated squirrel-cage motor selected to drive a friction-clutch type of production hoist on the high rating, but not requiring the high rating for pumping purposes.

One or two other well-pumping practices now found in the fields are worthy of consideration as money-savers. One is the use of electric time-switches to start and stop automatically the motors operating part-time pumpers on a lease, so that they will run on a predetermined schedule to stagger the operation and thus produce a lower and more uniform power demand. Where the power is purchased at rates

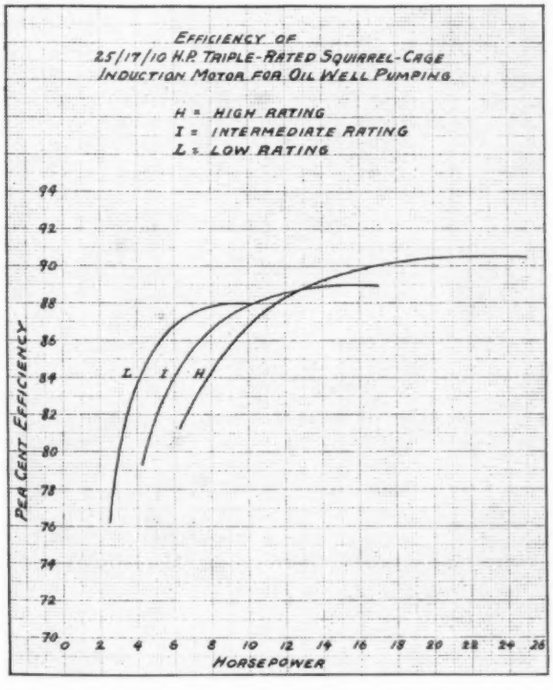


An outdoor installation of a triple-rated, splash-proof, 25/17/10 H.P., squirrel-cage motor on an oil well pumping rig in the East Texas oil field.

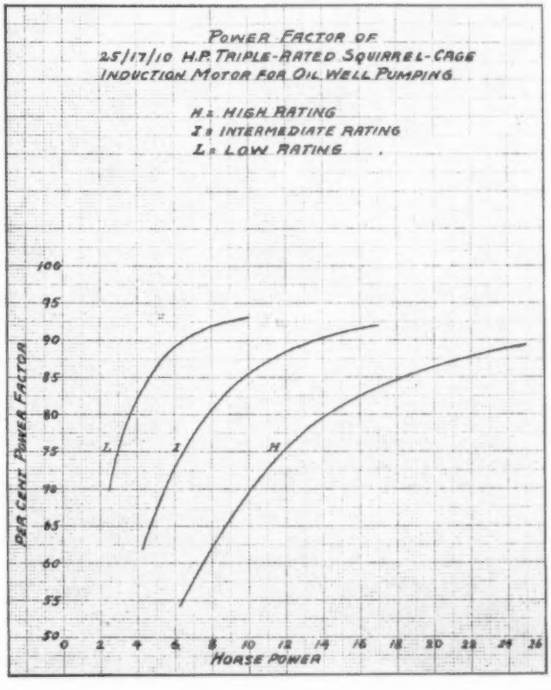
based on maximum demand, this will materially cut the power bill; and where the power is generated on the lease, it will reduce the size and cost of generating equipment required.

Another feature of modern installations is the use of outdoor equipment of all kinds, including motors and control. This eliminates the motor house, thus reducing the investment, the maintenance, and the loss in salvaging the material. The reliability of electrical equipment designed for outdoor use has given it a wide acceptance in the entire oil industry.

Efficiency curves for a 25/17/10 H.P. triple-rated squirrel-cage induction motor for oil-well pumping.



Power factor curves for a 25/17/10 H.P. triple-rated squirrel-cage induction motor for oil-well pumping.



Control of Drilling Mud in Deep Wells

Mud of Low Weight and Low Viscosity with Rapid Gel-forming Ability and Twenty-four Hour Mud Checking Together with Care in Drilling Advocated

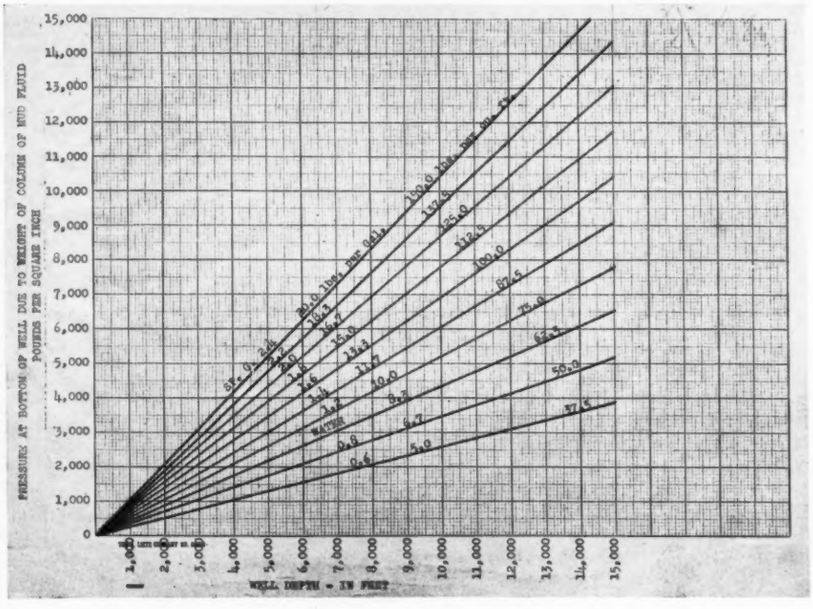
By George L. Ratcliffe
Vice President
Baroid Sales Company

DURING the past five years or so there have been approximately 40 deep wells drilled in the United States. By deep wells, I refer to those wells which have been drilled to a depth approaching or exceeding 10,000 feet. Few of these wells have been commercially productive, although a number of them have had showings of oil and gas sufficient to convince those in charge of the drilling of the wells that they should have been completed as producers.

The non-completion of some of these wells has given rise, from time to time, to discussion as to whether or not the producing sands had been "mudded-off" by the drilling mud. I do not believe there is any great possibility of these wells having been "mudded-off" in the sense that the drilling mud solids were forced into the producing sand in such a manner that pressure from inside of the sand would not remove them when the drilling mud was removed from the hole. In the first place, many of the sands found at these depths are of lower porosity and their pore spaces are correspondingly smaller than those of the upper sands, making it more difficult to drive the mud particles into the pores. In the second place all laboratory filter press tests—of which there have been a great number and variety—have shown that it is impossible to drive mud solids more than a very short distance into sands having porosities as high as 40 percent, even at differential pressures as high as 5,000 lbs. per square inch.

As far as the writer knows there is no reason to believe that the formation pressures in deep sands will not be as high in proportion to their greater depth as the pressures in shallower wells. If oil and gas are present in commercial quantities these pressures unquestionably should remove any filter cake formed on the sand when the drilling mud is removed. Deep producing fields so far developed seem to have had normal expected pressures. The Big Lake field in Texas, for example, had pressures of 4,000 lbs. to the square inch at depths of 8,500–8,900 ft. and the Kettleman Hills field in California originally had pressures of approximately 3,500 lbs. at 8,000 ft.

Figure (1). Graph for ascertaining the hydrostatic pressure at the bottom of a well due to the weight of the column of drilling mud in the well.



Referring to Figure 1, if we assume that the formation pressure at the bottom of a 10,000 ft. well is that which would be caused by a column of water extending from the surface to the formation, we find from the curve for water that we should expect to encounter a normal pressure of 4,340 lbs. at a depth of 10,000 ft. Even if the actual formation pressure was considerably lower than this expected pressure, it is hard to visualize a condition where the formation pressure would fail to remove any mud sheath deposited on or in the wall of the hole.

In a hole, say 5,000 ft. in depth, it is customary to use a clay drilling mud weighing between 9½ to 10 lbs. per gallon (71 lbs. to 75 lbs. per cubic foot) if no pressures exist in the hole. Where pressures exist or are expected it is customary to increase this weight, say to 11 or 11½ lbs. per gallon (82.5 to 86.2 lbs. per cubic foot). From Figure 1, the normal expected hydrostatic pressure due to water at a depth of 5,000 ft. would be 2,150 lbs. per square inch. When a mud weighing 11½ lbs. per gallon (86.2 lbs. per cubic foot) is used at this depth the pressure at the bottom of the well due to the weight of this mud column will be approximately 3,000 lbs. As this 3,000 lbs. exceeds the expected formation pressure of 2,170 lbs. by 830 lbs. this 830 lbs. provides a "factor of safety" of 830 divided by 2,150, or approximately 38 percent. If mud of the same weight is used in a well drilled to a depth of 10,000 feet, the factor of safety remains the same but the pressure at the bottom of the hole due to the drilling mud increases to 6,000 lbs. while the expected formation pressure is only 4,340 lbs. The differential pressure tending to drive water into the formation at this depth would then be 6,000 minus 4,340 or 1,660 lbs. which is just double the differential pressure which existed at 5,000 ft. As the actual formation pressures are, in most cases, lower than the expected formation pressures, this differ-

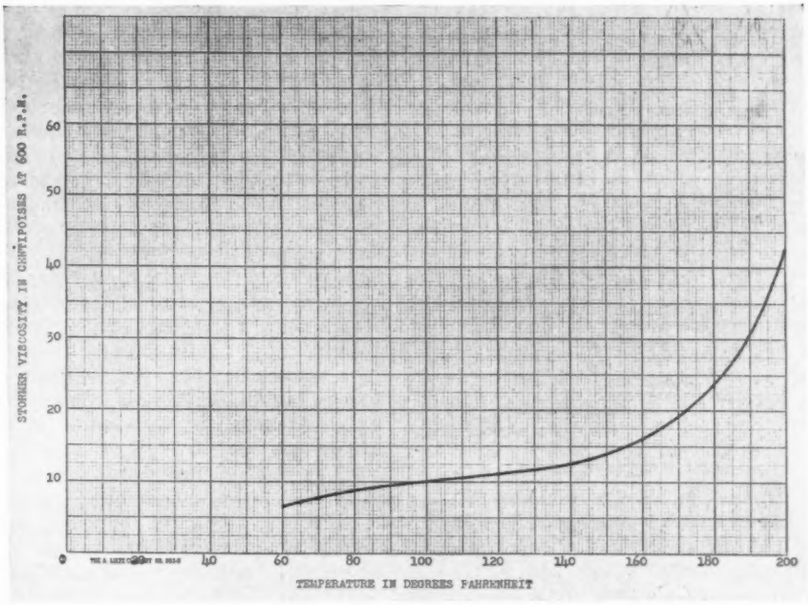
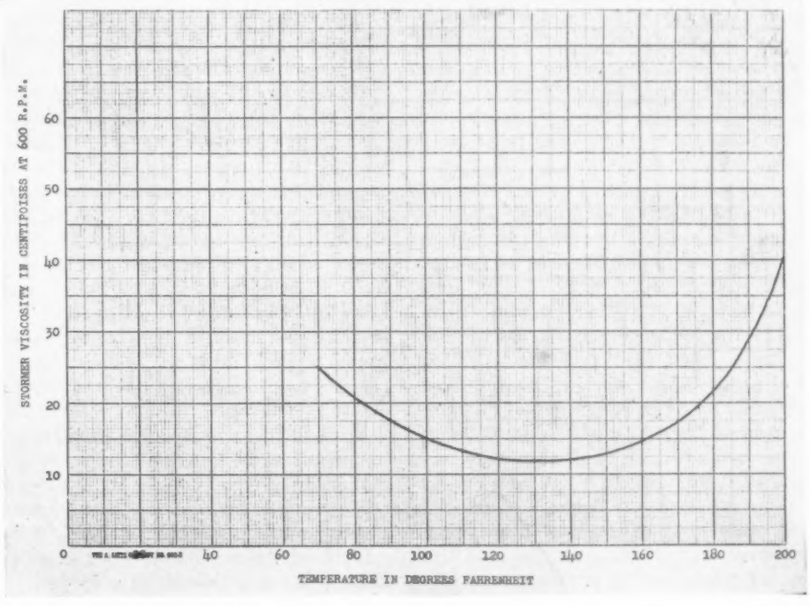


Figure (2). Graph illustrating the change in viscosity of a bentonite-water mixture due to the temperature of the mixing water.

ential pressure is usually even greater than calculated.

What is the effect of these greatly increased differential pressures in deep wells? In the first place, where ordinary clay drilling muds are used they undoubtedly result in more water being driven out into the formation before an impervious filter cake is built up on the face of the formation. Whether this is serious or not depends on the pressure in the formation, the size of the pore spaces in the sand and the colloidal content of the mud being used. If the pressure in the formation is high, it will be able to expel the water again without any difficulty when it is desired to complete the well. If it is extremely low—on the order of a few hundred pounds or so—the capillary attraction of the water, particularly if the pores of the sand are small, may be so great as effectively to seal off the sand and prevent production. The larger the pores in the sand the easier it will be for the pressure to expel the water. If a high percentage of gel-forming colloidal matter is contained in the drilling mud, an impervious filter cake will be quickly formed on the face of the sand and the water penetration reduced to a minimum. Filter-press tests show that an impervious film of concentrated gel-forming matter can be formed instantly on the face of a sand of ordinary porosity if the concentration of the colloidal material is approximately 7 to 10 percent. Such a film will be impervious to the passage of water at differential pressures as high as 5,000 lbs. per square inch, as demonstrated by tests. The concentrated colloidal matter used in these tests was a high grade bentonite, such as is sold commercially under the trade name of Aquagel. Bentonites vary considerably in their properties and where bentonite is referred to later in this article it will be understood to mean this grade.

Figure (3). Composite graph illustrating the change in viscosity of drilling mud due to increase in temperature. Data from average results of several investigators.



If the concentration of colloidal matter is low, it may take several hours or even a few days before an impervious cake is built up on the wall, and during this time water is being forced into the sand continuously. It is advisable, therefore, in deep drilling to be sure that the mud contains an adequate percentage of gel-forming colloidal material, either by proper selection of the clay base or by the addition of bentonite. In fact, it is always advisable to add bentonite to the mud in small quantities to replace the colloidal material used up in wall-building or otherwise lost in drilling. It is also advisable to keep the unit weight of the mud as low as is consistent with safety in order to reduce the differential pressures at great depths as much as possible.

Usually the presence of gas in the drilling mud is taken as evidence that high pressure gas has been encountered in the hole, but such is not always the case. There will always be gas in the drilling mud when drilling through a gas sand, whether the pressure is high or low, and whether the quantity of gas in the sand is great or small, as the gas contained in the pores of that part of the formation which is actually drilled up has no place to go except into the drilling mud. If the gas is under high pressure it may cause considerable trouble if drilling proceeds too rapidly, as a cubic foot of gas released under a pressure of 4,340 lbs. at 10,000 ft. will expand as it rises in the hole with the mud to approximately 300 cubic feet and lighten the mud column correspondingly, since gas only weighs about .05 lbs. per cubic foot. That is one of the reasons why it is necessary to increase the weight

of the drilling mud to provide an adequate factor of safety. The fact that gas at 10,000 ft. depth is normally under twice as much pressure as gas at 5,000 ft. depth and therefore will expand twice as much on the way to the top of the well, is an important consideration in deep wells. The effect of this gas can be minimized by either making hole more slowly or by increasing circulation to the point where the amount of gas entrained in each unit volume of mud is small enough to prevent serious complications.

After a gas sand has been drilled through and the hole is being carried deeper, no further trouble should be experienced from the gas, provided the face of the gas sand has been walled off with an impervious filter cake and the mud is being maintained at an adequate weight to keep the formation pressure from pushing the cake off again and escaping into the hole.

Unfortunately, however, ordinary drilling muds seldom contain enough colloidal material to wall up such a formation quickly, with the result that the mud remains gas cut after the bit has passed through the gas sand due to water being forced into the sand and gas being forced out into the mud column. This effect is aggravated in deep wells due to the greater differential pressures which increase the rate of filtration. With many low-colloidal muds it is doubtful if an impervious cake is ever built up, as the cake would have to be an inch or more in thickness and the rotation of the drill pipe probably keeps scraping it off as it is formed. If an adequate amount of colloidal material is contained in the mud, or is added to it in the form of bentonite, the cake will be made impervious and gas cutting will be stopped.

As bentonite increases the viscosity and gel strength of the mud, its addition must be carefully controlled and it must be added uniformly to all the mud. Fortunately chemicals such as Stabilite and combinations of quebracho, gallic acid, caustic soda, sodium silicate, and sodium diphosphate are available for reducing the gel-strength of colloidal muds, thus allowing adequate quantities of bentonite to be used to accomplish the desired results.

The control of the viscosity and gel-strength of the drilling mud has an important bearing on the successful completion of deep wells. All good clay drilling muds possess the property of being fluid while in motion and of gelling-up upon standing. Their viscosity or consistency is measured by means of a Stormer Viscosimeter or the Marsh Funnel Viscosimeter, or some modification thereof. This viscosity is dependent on two things, first the percentage of solids contained in the mud, and second, the percentage of gel-forming colloidal matter contained in the mud. Colloidal matter, weight for weight, will increase the viscosity ten times as rapidly as solids will increase it. Percentage of solids should always be kept as low as possible consistent with the weight required, so as to allow the maximum percentage of colloidal matter to be used, and still remain within viscosity limits. Solids should also be kept low because the higher the percentage solids the longer it takes to build up an impervious filter cake. It is necessary to control the viscosity of the mud carefully to enable sand and cuttings to be removed before returning the mud to the hole. Undoubtedly in deep wells separation of sand and cuttings from the mud should be accomplished by means of vibrating mud screens, because it is possible to keep the mud in much better condition by this method than it is by settling. Some drilling muds, on standing, will gel up and reach a maximum gel-strength in ten or fifteen minutes, whereas other muds will continue gelling for hours or days or even weeks. This gelling action is due to the presence of gel-forming colloidal matter and the higher the percentage present in the mud the longer it takes to reach its final gel-strength. No generally accepted method of testing gel-strength has been developed, although several different ones are in use and being experimented with.

Gel-strength is exceedingly important in a deep well. While coming out of the hole to change bits, while running casing, or during any interruption to the circulation the mud must be kept in such shape that it will, within a few minutes after circulation is suspended, form a gel sufficiently strong to prevent cuttings or mud solids from settling and yet the gel-strength must be kept low enough so that the mud does not solidify to the point where it is difficult to start circulation again. It is hoped that a field method of testing this property easily and quickly will be developed in the near future. The larger quantity of mud in the hole, the greater depth of the hole, the comparatively small clearances at great depths and the length of time required to make a round trip (on the Berry well of the General Petroleum Corporation in California it required 10½ hours to make a round trip at 11,000 ft.) make it imperative that the gel-strength of the mud be carefully controlled.

With further reference to viscosity it is important that this be kept as low as possible and particularly that the percentage solids be kept low when running casing in deep holes, particularly when using float shoes. If this is not done and the clearance between the pipe and formation is close, the casing is apt to act as a plunger and compress the mud in the bottom of the hole, sticking the casing or preventing it from reaching bottom. It is a good plan to replace the mud, if it is poor, with a new mud made up of approximately 4 percent bentonite and water before running long strings of casing. This is economical as it only requires four or five tons of bentonite to replace the mud in a 10,000 foot hole. This of course cannot be economically done in holes that require heavy muds as it would be necessary to replace all the weight material also.

In adding bentonite to the mud in deep wells it must be borne in mind that the temperatures at the bottom of the hole are considerably higher than at shallower depths. Temperatures increase at an approximate average rate of 1 deg. F. for each 50 to 65 ft. of depth, although temperature is not exactly a straight line function of depth and varies in different fields. In the Big Lake field temperatures of 185 deg. F. to 190 deg. F. were encountered at a depth of 8,500–9,800 ft. A temperature of 236 deg. F. was obtained at a depth of 9,600 ft. in General Petroleum's No. 1 Berry well in California and projection of the temperature curve on this well gave an indicated temperature of 300 deg. F. at a depth of 11,377 ft. Temperatures at 10,000 ft. depths can be expected to be somewhere in the neighborhood of 250–300 deg. F. Figure 2 shows the effect of the temperature of mixing water on the viscosity of bentonite-water mixtures and it can be seen readily that if a mud of the proper viscosity containing bentonite was introduced into the hole it would have a considerably higher viscosity after making a round trip and being subjected to the high temperature at the bottom of the well. In adding bentonite to the mud under such conditions the proper procedure would be to add small percentages at a time and wait until the mud returned to the surface to determine the effect of the temperature. This increase in viscosity and gel-strength can also be counteracted by the addition of suitable chemicals, as previously noted.

It will be noticed also from Figure 3 that these high temperatures also increase the viscosity of ordinary clay drilling muds. Figure 3 is an average composite curve made up from the data secured by several investigators working on different muds. In general, pressures make no important change in the mud except to filter water out of it into the formations. The same remarks that apply to the addition of bentonite to the mud in deep wells therefore also apply to the addition of ordinary clay to such muds only to a lesser degree.

The theory has been advanced by some that the high temperatures at the bottom of such deep holes might dehydrate the mud, and cause it to bake on the walls, but such a theory does not seem plausible as it would be impossible to distill the water out of the mud at the pressures existing in the hole at that depth. It seems more reasonable to believe that the effect noticed has been due to the thickening of the mud at those temperatures. This action is probably due to an increase in the solubility of certain dispersing agents always present in the mud (or the bentonite) and a resulting increase in the gel-strength.

Another important consideration in deep wells is the effect of the pH value or Hydrogen Ion concentration of the mud. Ambrose and Loomis ("Chemical Treatment of Rotary Drilling Fluids", Industrial and Engineering Chemistry, p. 1019, Sept. 1933) found that Baroid muds having a pH of 10.5 to 11.5 stayed in suspension indefinitely whereas settling took place at lower pH values. Undoubtedly the pH value of any mud in a deep well should be maintained at a point that will prevent any settling, and this is an important fact to remember when treating with chemicals as otherwise the pH value may be lowered to the point where there will be dangerous settling and if lowered below 7.0 the mud will be acid and have corrosive properties destructive to casing and equipment.

Probably the most important item in the drilling of deep wells is careful, continuous checking and control of the mud by an engineer or other employee who is made responsible for this phase of the work. Enough men should be used to make a continuous 24 hour check possible. Hourly records should be kept of the weight, viscosity, temperature and gel-strength of the mud, and a system should be devised and installed which will enable additional clay, colloidal matter, weight material or chemicals to be added promptly when necessary to change the characteristics of the mud.

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Revolutionary Development in Fishing Practise

WHILE the improvement in fishing tools has largely kept pace with the increasing demand upon their strength, accuracy and resourcefulness in coping with the larger problems involved in the constant increase in the depth to which producers have found it practicable to go for oil, there has been one problem which has remained a stubborn menace in all territories where a soft formation is encountered immediately below a hard one, and that is the recovery of lost pipe.

Pipe is lost in a cavity either (a) when a twist-off has occurred while drilling through a soft strata between two hard ones, which is sometimes unavoidable because even with the greatest of care the string is unable to stand the added strain of operating without the steadying support of more or less solid formation, or (b) when a cut has been made to recover stuck pipe in an open hole without due reference to the log of the well. In this case if a place is selected for the cut either immediately above or below an offset in the hole the tension in the released end is apt to cause it to snap back into the wall if a cavity is present at that point, making it very difficult to find.

The problem of recovering lost pipe has always been greatly augmented by the fact that it is so quickly frozen by the settling out of the mud. Moreover, even when found and brought back into the center of the hole by the tools of the wall-hook variety which have been constructed for that purpose and brought to a very high point of efficiency during the past few years, the fish is not apt to stay upright but has a tendency to settle back out of reach again as soon as it is released. Thus if the fish does not yield to such pull as it is possible to exert upon it the first time and the driller is forced to come out of the hole to put on wash pipe or other equipment to loosen it, he frequently is unable to locate the fish upon his return without a second recourse to the wall-hook procedure. This danger naturally increases in proportion to the increase in the depth of the hole. Countless jobs have had to be sacrificed because of the inadequacy of any known tool.

Constant study of this problem over a period of years by the Specialty Oil Tool Company has made possible its perfection of the Soto Wash-Over Wall-Hook, which locates the fish and brings it to grips with the equipment selected as best fitted to extract it from the hole in one and the same operation.

This double function is made possible by joining the heavy wall-hook arm necessary to locate the fish to a body and head through which perfect clearance is allowed, even to the passing of tool joints past the valve. The joining is accomplished by means of ball and socket joints and hinge pins threaded directly through the head and body on either side of the tool. The body contains a flapper valve enabling the opening of the tool to be controlled by hydraulic pressure—the wall hook swings out any time the pump goes on unless the fish is up in the tool—thus permitting extended exploratory rotations without the necessity of coming out of the hole for additional adjustments if the fish is not encountered on the first trial. With this new tool the washing-over process can begin immediately upon the location of the fish.

The procedure followed in one of the actual jobs where it has been used might be of interest at this point. The accompanying series of drawings will depict what happened in the Wilshire Oil Company's well No. 2 in Petrero, California where the situation encountered was typical of many deep well fields. A twist-off had occurred and some 3,000 ft. of pipe was found to be unrecoverable by ordinary fishing methods. Two inside shooting jobs complicated the problem presented when the wash-over tool went into action. The operator was still

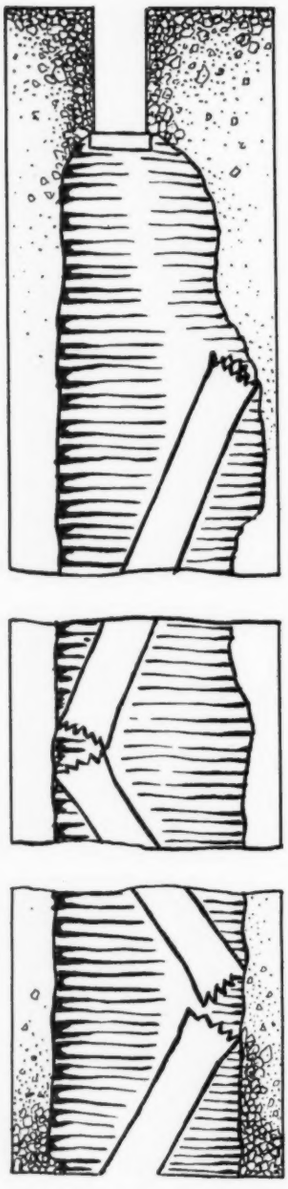


Figure 1: Pipe lost in open hole below 7⅝ in. shoe at depth of 4,000 ft.

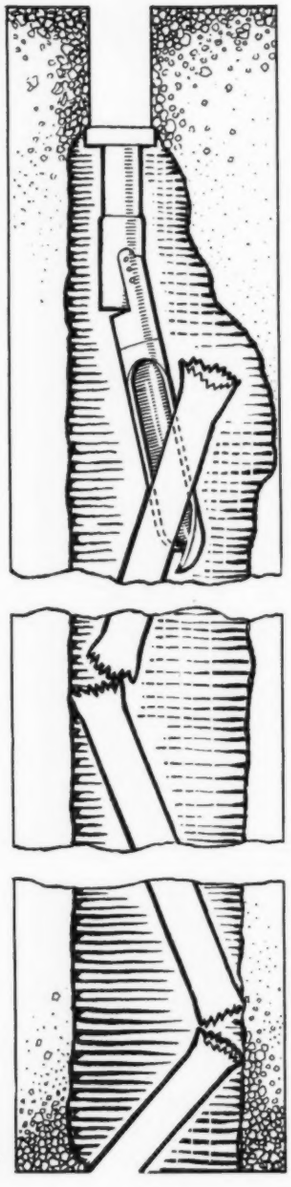


Figure 2: Wash-over wall-hook with cutter above.

contacting the damaged pipe some 20 feet below the 7 and ⅝ shoe which terminated the casing at a depth of approximately 4,000 ft., but was unable to get hold of it, a condition set forth by the artist in Fig. 1.

Figures 2 and 3 tell the story of the first hour's fishing.

Figure 4 shows the short arm on the wash-over wall-hook going back into the hole with cutter immediately above. On this trip the hole was cleaned down to the first shooting job.

At that point the hydraulic knuckle was used in conjunction with the Sotco Combination socket which has a mill bottom, and the slivers on the exploded top of the fish were milled down until it was smooth enough to steer up inside the string. For the purposes of this paper it was thought unnecessary to supply further drawings. When the milling process was completed the wash-over wall-hook and cutter were once more installed in the string and successive cuts were made until the hole was cleaned to bottom, some 3,000 feet of pipe being extracted in all.

Figure 3: Over fish in 15 minutes—out with a cut in an hour.

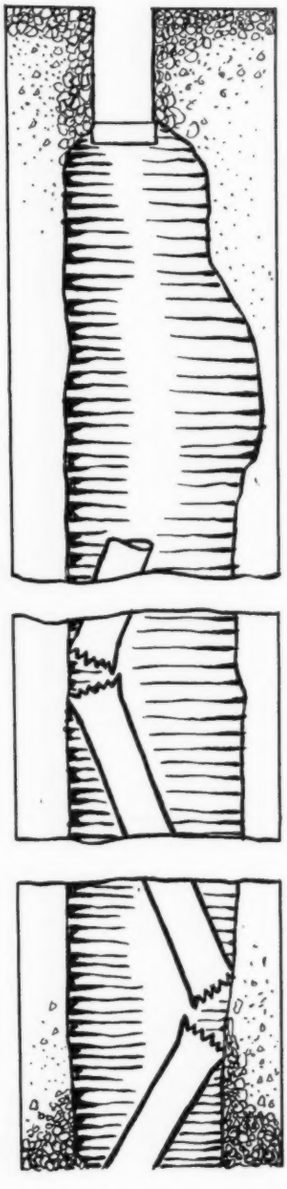
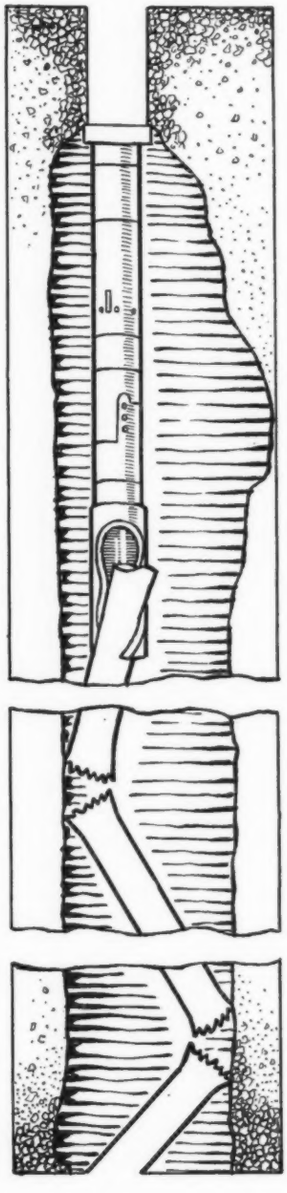


Figure 4: Wash-over wall-hook using short shoe adaptable to rough surfaces with cutter and four stands of 70.D. wash pipe above.



World Petroleum Abstracts

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Industry.

Dr. O. W. Wilcox

Petroleum Geology

Prediction of Overhang at Barber's Hill; A Study in Quantitative Calculations from Torsion-balance Data.—Donald C. Barton, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 1, pp. 25–36, 2 figs.

This study was made to see whether or not the presence of the overhang at such a dome as Barbers Hill could be determined by calculation from the data of a torsion-balance survey, in advance of determination of the overhang by the drill. The study was based on the assumptions that the form of the top of the cap and the depth to the top of the salt table were known but that there were no drilling data available to show whether or not overhang actually was present. Calculations were then made from the results of the torsion-balance data to see whether or not the presence or absence of overhang could be determined with good, fair, or poor probability of accuracy.

The result showed that the overhang could be predicted in advance of drilling solely on the basis of torsion-balance data, plus available data as to cap and salt. The gradient profiles which would be produced by assumed forms of the dome were calculated by the author's graphical method.

Effect of Anisotropy on Apparent Resistivity Curves.—Sylvain J. Person, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 1, pp. 37–57, 7 figs.

As a contribution to the rapidly developing science of geophysical petroleum surveys, the author investigated the anisotropic character of sedimentary formations, which has so far been overlooked in the interpretation of resistivity curves, and offers a method of interpretation for solving completely a 3-layer resistivity curve, which gives results acceptable within a probable error of 5–10 percent.

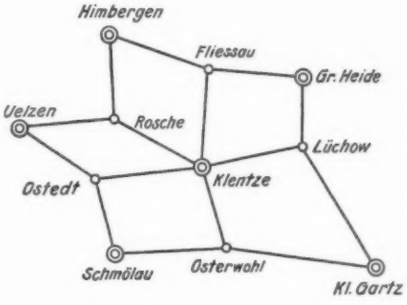
Structure of the Turner Valley Field, Alberta.—P. D. Moore, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 18 (1934), No. 11, pp. 1417–1453.

Turner Valley is structurally probably the most complicated oil field in North America. It is a highly folded and faulted compound anticlinal overthrust sheet bordering the outer Foothills Belt of Alberta. It involves Paleozoic limestones, dolomites, and shales, Jurassic shale, and Cretaceous rocks. From the surface, the structure appears to be rather simple, with apparently uninterrupted east and west rim rocks of Belly River sandstone enclosing Colorado shale. The major overthrust fault, which underlies part or all of the structure, is of considerable magnitude and appears to be warped. No connate water has been encountered in either the limestone or the upper producing sands. The heavier oils are found in the youngest formations and show a progressive decrease in gravity with depth.

This paper contains a discussion of the salient structural features.

Viewpoints for the New German Gravimetric Survey.—A. Berroth in OL UND KOHLE, vol. 11 (1935), No. 1, pp. 6–8.

By order of the Reichsfuhrer a comprehensive geophysical survey of Germany is to be made; the principles that are to govern this survey are here explained. In order to eliminate or reduce the average error of observation, all measurements will be related to master measurements, carried out with the greatest possible accuracy at Potsdam. The Potsdam data will be correlated with similar data taken at control stations about 50 kilometers apart, as indicated by the accompanying sketch; this will give a series of polygons



similar to a system of primary triangulation in a topographic survey. To obtain checks two instruments will be employed, the Haalck gravimeter and the Thysens-Seismos gravimeter, which allow of more rapid measurements than a pendulum instrument. The primary points being established with great care with two standard instruments, the intermediate territory will be more rapidly surveyed for preliminary location of major features, which will later be more intensively examined. It is required that the standard error shall not exceed about 1 milligal.

Normal Geothermal Gradient in the United States.—C. E. Van Orstrand, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 1, pp. 78–115, 2 figs.

In view of the constant use of the term "isothermal gradient" in geological literature it is necessary to define it properly and to state the limits of the definition so far as possible from existing data.

Summarizing the evidence, it appears that the normal gradient in the first 1,000 feet of sediments is probably greater than 65.2 feet per °F. (35.8 meters per °C.). The determination of an upper limit is not easily made. Assuming an arbitrary value of 82.8 as an average, and a minimum of 62.14, we have for the maximum reciprocal gradient, 103.5 feet. The mean from 9 locations exclusive of the oil fields is 108.0. It seems reasonable, therefore, to assume that the average of a large number of gradients covering the entire area of the United States, that is, the reciprocal of the normal gradient corrected for surface topography, is certainly greater than 60 feet per °F. (32.9 meters per °C.) and probably less than 110 feet per °F. (60.4 meters per °C.).

The wide interval between the preceding limits may seem unjustifiable, but when it is recalled that we have practically no observations in the large areas surrounding domes and anticlines, where the temperatures are presumably low, it is evident that a large element of uncertainty enters into our calculations. For depths exceeding 1,000 feet, the preceding numbers should probably be replaced by numbers of a lesser numerical magnitude. Existing observations do not give us very much information on this point.

The corresponding estimates for undisturbed basement rocks are: 100 feet per °F. (54.9 meters per °C.) for the minimum and probably not less than 200 feet per °F. (109.7 meters per °C.) for the maximum. These estimates are based on the data from northern Ontario, Canada (118.4 to 233.2).

Effect of Moisture Upon Velocity of Elastic Waves in Amherst Sandstone.—W. T. Born and J. E. Owen, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 1, pp. 9–18. 6 figs.

Laboratory measurements of the velocity of elastic waves in Amherst sandstone show that the bar velocity is dependent on the moisture content, the velocity decreasing as the moisture content is increased. Bar velocities ranging from 7,640 to 4,415 feet per second were observed. It is shown that the change in velocity is caused primarily by a change in the value of Young's modulus of the material. The suggestion is made that this phenomenon may have some bearing on the question of Gulf Coast reflection surveys.

Deep Electrical Prospecting.—J. C. Karcher and Eugene McDermott, in BULL. AM. ASSOC. PETROL GEOLOGISTS, vol. 19 (1935), No. 1, pp. 64–77. 7 figs.

By deep electrical prospecting is meant depths of a half mile or more. Most data so far published refer to depths appreciably

shallower than this. A continuous current field is most satisfactory together with electrode spacing comparable with the depth of the insulating media. Electrical prospecting is here regarded in the light of its ability to determine the presence of insulating rather than conducting media. Use is made of resistivity determinations at various electrode spacings together with inductance and resistivity slope functions. Inductance is determined by measuring the time constant of the current delay. Three areas are considered. One, the Hugoton gas area, Stevens County, Kansas, is an ideal case for the electrical method. In the other two cases considered, the Hebbronville area, Jim Hogg County, Texas, and the Anderson County, Kansas, area, the electrical method is quite ineffectual.

Oil Well Operation

Extinguishing a Burning Oil Well by a Deflected Hole.—Jos. D. Hughes, in OIL WEEKLY, vol. 76 (1935), No. 5, pp. 27–29.

A burning and cratered oil well in Texas was extinguished and killed by means of a deflected relief well, which is said to be the first instance of the kind. The relief well was started 386 feet distant from the burning well, drilled to an average angle of about 15 degrees, and sunk a distance of 2,405 feet; mud circulation was established between the two wells and the fire extinguished. Control of the relief hole was maintained by the use of a single shot surveying machine which was employed every 50 feet, and it is evident that a high order of precision was attained, even at the high speed called for by the situation. A total of 16 whipstocks was oriented and drilled off in the course of the work.

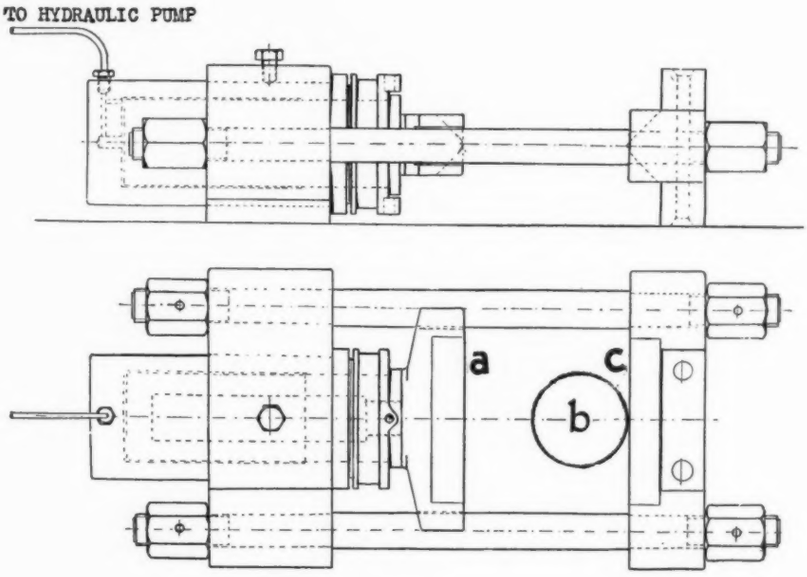
Essentials in Completing Deep Holes.—L. G. E. Bignell in OIL & GAS JOUR., vol. 33 (1935), No. 33, pp. 34–36.

It is noted that so far there are ten wells that have been drilled below 10,000 feet, but none of these has been brought in as a commercial producer, although several report good showings before cementing long strings of casing. There are other numerous instances of wells drilled below 6,500 feet that are non-producers, in spite of "showings." The deepest producing field in the world at this time is the Big Lake field in Reagan County, Texas, where there are 15 wells producing from 8,100 to 8,500 feet.

In furnishing an explanation as to why the deep Big Lake wells are producers and deep wells elsewhere are not, the author is inclined to lay principal blame on overloading, meaning the use of a heavier mud than is required for safety in drilling. Safety is the main requirement in wildcat drilling, but safety does not necessarily require the application of pressures that are too strong to allow the formation to give up what is in it, so that a producing horizon may pass unnoticed. (Since the introduction of "electrical coring" methods this overlooking of pay formations has not infrequently been proved.—ED.) Specifically, the success of the Big Lake deep wells is very probably due to the fact that in this field there was no "fighting the formations," which on the contrary were given every possible chance to produce. This "chance to produce" was afforded by a combination of the use of properly conditioned mud with well-head control. For instance in one case a 1,900-lb. gas zone at 8,200 feet could not be penetrated and the well kept alive at the same time, as the pressure of clear water at that depth was about 3,600 feet; high pressure gas was introduced down the drill pipe simultaneously with water from the slush pumps; with 800 feet of gas per bbl. of drilling water the column pressure was lightened to not exceed 1,900 lbs. at the bottom of the hole, so that the formation could discharge its gas. The author is confident that less fighting the formations would have made different stories of some $150,000 to $500,000 wildcats.

A New Pipe-squeezer for Preventing Well Fires.—J. F. Kesper, in OEL UND KOHLE, vol. 11 (1935), No. 3, pp. 51–52.

As a precaution against disastrous well fires or eruptions the firm of Trauzl-Vienna have evolved the arrangement illustrated in the accompanying sketch. The well casing *b*, which may be one of the upper sections, is enclosed between the jaws *a* and *c* of the pinching mechanism as shown. The jaw *c* is fixed against one side of the pipe; jaw *a* is attached to the plunger of a hydraulic press, the cylinder of which is kept full of water or glycerine and connected with a pump which may be



located several hundred yards from the well. If a fire breaks out or a gusher gets out of hand, a few strokes on a hand pump by two men will be sufficient to pinch the pipe to such an extent that further escape of gas or oil will be prevented or greatly reduced.

Relation of Sub-surface Factors to Well-head Control.—K. W. G. Patterson, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 20 (1934), No. 134, pp. 1100–1112.

The rate of flow of oil from a well at the surface is the final result of a combination of factors, each of which exerts a specific influence which tends either to increase or decrease the rate of flow. The matter is complicated by the great number of factors involved, but it is possible to make some broad definitions and to set up a mathematical formula by which the effects of different factors may be judged. The author introduces a new term, "impedance," into calculations of this sort, and defines it as hindrance to flow induced by the particular characteristic of the sand and the viscosity of the oil. The relation of velocity of flow to "radius of influence" is insisted on. Some interesting examples are given.

Economics of Pumping and Gas Lift.—T. W. Dagg, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 21 (1935), No. 135, pp. 25–35.

The author enumerates some of the principles involved in the choice of pumping or gas lift as alternative methods of artificial lift, and he makes the point that the petroleum engineer should be thoroughly familiar with both and not partisans of either, otherwise his judgment will be warped when considering the economics of a particular well or field. Both methods have their advantages in relation to the general circumstances. Decisions should not be too hastily taken on the basis of short-duration tests.

The choice of method is affected by various circumstances. Among these are the mechanical condition and verticality of the hole. Obviously plunger pumping is uneconomic in very crooked holes, due to excessive wear on rods, tubing, and casing. A statistical comparison shows that the economic limit of deviation is about 2½° per 1,000 feet of hole, though in some cases as much as 23° is not inadmissible. Wear and tear may be much reduced by the use of wooden sucker-rod protectors, and also by decreasing the number of pumping strokes per minute. Sandy wells should, if possible, be gas-lifted; the actual percentage of sand that makes pumping wells uneconomic depends on the viscosity of the oil and the abrasiveness of the sand. In very sandy wells the use of mushroom valves with a large fluid passage is advisable. A series of

experiments carried out in the Mene Grande field, Venezuela, showed that, in a straight gas-lift well, for a fixed diameter of tubing and the same velocity, the lift efficiency is directly proportional to the viscosity up to the point of predominance of slippage. Thus high viscosity is not necessarily a deterrent to the use of straight gas-lift. Where the natural gas-oil ratio is high, gas lift is naturally more economical than plunger pumping, and here the choice becomes a matter of cost of installation taken in connection with the productivity and probable life of the well. The tendency to paraffinization and emulsification is also to be considered.

Natural Gas

Preparation of Hydrocarbons of the Benzene Series from Methane.—S. Ando, JOUR. SOC. CHEM. IND., Japan, vol. 37 (1934), No. 10, p. 630 B.

Following up the noteworthy work of F. Fischer on petroleum derivatives as raw materials for organic syntheses, the author investigated the thermal transformations of methane gas in quartz tubes. The best yields of benzene oils were obtained by passing the gas through quartz tubes of 4.5 millimeters inside diameter, the outside temperature being 1,200° C., and the rate of gas flow of 25 to 30 liters per hour. Porcelain tubes are not as suitable as gas, and all catalyzers, except pumice, merely favored the splitting of the methane into carbon and hydrogen. The yield under the conditions stated is 25 grams of oils and 25 grams of tar per cubic meter of gas.

Deterioration Rate of Absorption Oils.—W. E. Kuhn and J. F. Collins, Jr., in NATL. PETROL. NEWS, vol. 27 (1935), No. 3, pp. 21-26.

There is a lack of satisfactory tests that will show when an absorption oil in a batch system should be renewed, or to determine the rate at which new oils should be added as make-up in a continuous system. Such tests should show when gums have accumulated in amounts sufficient to lower the absorbing efficiency of the oil, so that changes may be made on definite information rather than at arbitrary periods.

For laying the basis of such tests the authors examined a number of physical and chemical procedures that show the character of the changes that occur within an absorption oil while in service. The literature of the subject was found to be scant and barren of the information desired. Among the ordinary tests finally adopted by the authors for the purpose are gravity (both A.P.I. and sp. gr.), and the A.S.T.M. distillation test, which will show the relative percentage of light fractions left by improper stripping. Viscosity A.S.T.M. proved to be non-revealing. Chief importance however, is ascribed to the demulsibility test and a modified Gill gum test. The authors say of the demulsibility test that its importance can hardly be overestimated for determining the "life" of an absorption oil. The most consistent and reliable results were obtained with a modified demulsibility test proposed by Kallam, which consists in thoroughly agitating equal volumes of oil and distilled water for a period of three minutes, and noting the time required for complete separation. This "demulsibility number" is a function of the gum content, which is determined by a modification of the Gill method, as follows:

Reagents required: Nitro-sulphuric acid (1 HNO_3, 2 H_2SO_4 by weight); naphtha (Belgian asphalt A.P.I. 85.1–86.6; dist. 86°–158° F); ammonia solution (1:1), and acetone.

Mix five grams of oil with 11 grams of nitro-sulphuric acid, stir 10 minutes, cool and let stand at 10°–15° C. for exactly 2 hours; mix thoroughly with about 30 cc naphtha, carefully decant the naphtha and repeat four times or until the wash naphtha contains no oil; neutralize with ammonia (caution) until color of solution is dark brown; then add an excess of ammonia, suction-filter the gum and wash free of ammonia salts, dissolve gum in acetone, evaporate, dry, and weigh. The applications of the method to plant practice will be reported later.

Liquefied Gas as Truck and Bus Fuel.—J. C. Albright in NATL. PETROL. NEWS, vol. 27 (1935), No. 9, pp. 48–51.

The use of propane and butane mixtures as fuel for automotive vehicles is fast progressing in California, and is now limited chiefly by lack of refueling stations and tanks adapted to hold this particular fuel; such tanks, however, are being developed.

At present the principal users of this fuel are trucking companies that operate fleets of heavy duty trucks and omnibuses for long distance traffic, in some cases up to 30 tons gross load. The proportions most used are 80 percent butane and 30 percent propane, with octane rating of 100; the average cost of converting trucks from gasoline to butane-propane is $180 per unit; the average mileage of a 103 H.P. truck on butane-propane is given as 4½ per gallon, as compared with 3¾ per gallon of gasoline.

Petroleum Refining

Treatment of Iraq Crudes.—G. Egloff and E. F. Nelson, in REV. PETROLIFERE, No. 615 (1935), pp. 105–106.

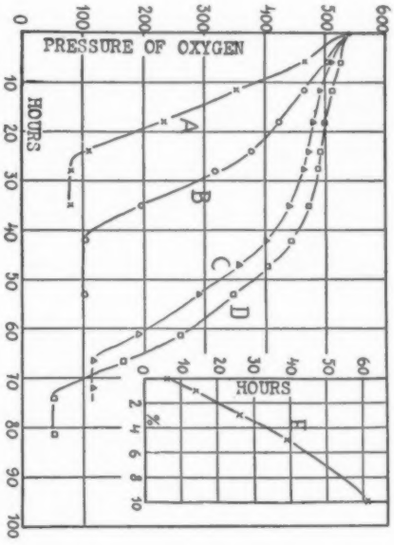
It is shown that by Dubbs cracking it is possible to obtain from a Baba-Gurgur residue a yield of 41.2–44.2 percent of gasoline and a fuel oil corresponding approximately to "Bunker C." The Iraq cracked gasoline is rendered sufficiently free from sulphur by acid and soda treatment.

New Solvent Unit in Operation.—N. Williams, in OIL AND GAS JOUR., vol. 33 (1934), No. 32, pp. 39–41.

Details are given regarding a 2,000 bbl. plant put in operation by the Magnolia Petroleum Co. for refining lubricating oils by two selective solvents on the countercurrent principle. The plant operates mostly on Oklahoma crudes. The charge of oil to be refined is at the rate of 27,200 pounds per hour, for which are required 88,000 lbs. of paraffinic solvent (propane) and 104,000 lbs. of naphthenic solvent (cresylic or tar acids with a minimum of 35 percent phenol). The finished product is a dewaxed 0.8035 V.G.C. oil with viscosity index of 100. The ratio between the propane and phenolic solvents has a distinct effect on the product; more propane improves the color but unfavorably affects the viscosity index and V.G.C. A recovery of 76 percent paraffinic oil and 24 percent naphthenic oil is being obtained. The separation is accomplished in nine successive stages, represented by as many pots or compartments in the two extractors, the construction and operation of which are described and illustrated.

An Economic Method of Refining Cracked Gasoline.—E. Vellinger and G. Radelescu, in PETROLEUM, vol. 30 (1935), No. 4, p. 13.

In the refining of cracked gasoline two objectives are sought that are practically incompatible; one is to remove the gum-formers, the other is preserve the anti-knock quality. The sulphuric acid treatment used by most oil refiners separates both desirable and undesirable substances, and still gives a product of little stability, so that inhibitors have to be added. It has been observed that the acid-treated gasoline forms more gum than the crude product, which obviously points to the fact that the treatment removes natural inhibitors.



In the course of an investigation at the "Ecole Nationale de Petrole" at Strasbourg it was observed that natural inhibitors could be detected only in the fractions above 130° C. By photochemical methods these were identified as phenols. On the basis of this observation the authors propose the method of separating the cracked gasoline into a light and a heavy fraction, the point of separation being 140° to 150° C. (Cross and Carbural). The lighter fraction is then subjected to the usual treatment, while the heavy fraction, containing the natural inhibitors, is left untreated, and the two fractions are then mixed in proportions to obtain the desired characteristics.

The accompanying diagram shows the oxygen absorption, under the action of light, of various gasolines compounded according to this method. Curve A shows the oxygen absorption (in terms of decrease of pressure) of the refined light fraction; B, the product A

mixed with 3 percent of the fraction 142°–154°; C, the same with the fraction 154°–162°; D, same with the fraction 168°–173°. E shows the induction periods in hours with mixtures of active fractions.

Color Stabilization of Gasoline by Amines.—L. V. Sorg, in IND. ENG. CHEM., vol. 27 (1935), No. 2, pp. 156–160.

The color of a gasoline, and with it the color stability, has always been an important factor from the sales viewpoint. While dyeing of gasoline has, in many cases, eliminated the close control over color that was formerly required, the problem has in no sense been entirely eliminated. Many of the gasolines that are marketed undyed are third grade and are often found to be rather color-unstable. Also, dyed gasolines are to be found that become "off-shade" in the sunlight from the color instability of the gasoline itself.

The normal aliphatic amines, up to and including the amyl amines, are shown to possess color-stabilizing properties. While the amino group is probably responsible for the color-stabilizing action, its effectiveness is modified by the length and number of alkyl groups attached. The amyl amines are the most effective of the various amines examined, and of them the primary and secondary are best.

Little additional improvement in color stability is to be gained during a one-hour exposure in sunlight in using over 0.003 percent by weight of a given amine. The natural stability of the gasoline being treated does not greatly affect the amount of amine necessary to secure maximum possible color improvement, but the magnitude of the maximum possible color improvement varies with it.

The amyl amines pass through the operation of sweetening with plumbite and sulphur with no loss in effectiveness toward sunlight color stabilization.

Unique Fractionating Column.—John C. Albright in NATL. PETROL. NEWS, vol. 27 (1935), No. 6, pp. 20F–24.

The author describes the new fractionating tower of the Hancock refinery at Signal Hill, Calif., which strips five products from 17,000 bbl. of crude daily. The column has an inside diameter of 84 inches, is 110 ft. high, with 38 bubble trays and three draw-off pans; each tray has 72 bubble caps of peculiar design, which are fully described. The total arrangement is such that very close cuts may be made of the various fractions.

Refining Lubricants by Phenol in France.—R. K. Stratford and J. L. Huggett, in OIL AND GAS JOUR., vol. 33 (1934), No. 32, pp. 44–46.

This paper is a discussion of the basis of the phenol process for refining lubricating oils as carried out at the new Port Jerome refinery in France. This plant has a charging capacity of 3,500 bbl. a day and up to the present has worked only Colombian lubricating distillates. One or two lubricating oil cuts are taken from the vacuum side of the crude flash coil; these stocks are then given a phenol treat and the raffinate is then re-run in a vacuum still where the desired lubricating oil fractions are obtained and run directly to lubricating storage. The extract from the phenol treating process is used in France as cracking stock, or for improving the emulsifying property of asphalt. The plant consists essentially of three parts: a pair of countercurrent treaters, one for light and the other for heavy lubricating distillate, a phenol separator, and a phenol recovery unit. Contact between phenol and oil is effected in seven stages, each with the necessary mixer, settling drum, pumps, etc. the flow from stage to stage being entirely automatic. A flow sheet is given in the paper.

Acid Treatment of Hydrocarbons.—K. Ewing and J. F. Kesper, in BRENNSTOFF CHEMIE, vol. 15 (1934), pp. 474–475.

In this process the hydrocarbon is atomized through a fine spray in the acid, the object being to secure thorough treatment while keeping the volume of acid at a minimum. Detailed plans of the installation are given.

Refining Paraffin with Ferric Sulphate.—Biluchowski and Dobrowolski in PRZEM. CHEM., vol 18 (1934), No. 10–12, pp. 309–313; Rev. Petrol. No. 618 (1935), p. 211.

Crude paraffin of melting point 50–52° C. was treated at 135–138° C. for three hours with 3.7 percent of ferric sulphate, 3.7 percent of tonsil (an active clay), and 0.47 percent of carbonate of soda and filtered through an asbestos filter. The paraffin recovered had a white color and a very faint odor.

On a cost basis the use of ferric sulphate for this purpose is on a par with sulphuric acid, with the advantage that the paraffin is more easily recovered from the sulphate residue than from acid sludge. Chromic sulphate appears to be less advantageous for the purpose.

Survey of Fuel Consumption at Refineries in 1933.—G. R. Hopkins in U. S. BUR. MINES REPORT OF INVESTIGATIONS, No. 3270 (Feb. 1935).

An apparent decline in fuel efficiency at refineries, which first became evident in 1930 and continued through 1932, was checked in 1933 when the average amount of heat needed to refine a barrel of crude oil amounted to 660,000 B.t.u. This compares with an average requirement of 692,000 B.t.u. in 1932 and with a low of 639,000 B.t.u. in 1929. The improvement in fuel economy in 1933 probably was closely related to the increase of 5 percent in crude runs to stills. As much of the fuel burned at refineries is utilized for purposes other than under crude-oil stills and in relatively stable amounts, it is evident that a material increase in crude runs will usually be reflected in a decrease in average fuel requirements. Another factor which has influenced fuel economy at refineries in the past is the trend in cracking, a refining process requiring more than the average expenditure of heat. In 1933 production of gasoline by cracking increased slightly, but no appreciable rise in heat requirements resulted as an equivalent amount of fuel was saved in improved technique, particularly in the field of heat exchange.

Oil supplied 35.1 percent of the total heat units consumed at the refineries during the year. Acid sludge as fuel amounted to 4,990,000 bbl., a considerable decrease from 1932, which is ascribed to smaller production and better firing technique. There was a surprising increase in consumption of coal as refinery fuel, principally in the Appalachian district. The steady decline in consumption of natural gas as refinery fuel, which began in 1928, has continued, due to curtailment of refining operations in the Rocky Mountain district. There has been a steady growth in the use of still gas. The consumption of petroleum coke has continued to decline.

Improved Oil Made by New Process.—Anon, PETROLEUM WORLD (Calif.), vol. 32 (1935), No. 2, pp. 19–22.

The Associated Oil Company refinery has at Avon, Calif., evolved a process for making solvent-refined lubricants, using a double vacuum distillation which eliminates clay treatment. In this process a wax-free crude is used, from which a lube distillate of 200–400 seconds at 130° F. is obtained. This is first treated by the Edeleanu process, where it is separated into 35 percent extract and 65 percent raffinate. This raffinate is pumped through a Foster Wheeler re-run vacuum unit where lighter fractions are removed and four streams of lube distillates are obtained. An exceptionally clean separation of asphaltic compounds results. Each stream is cut to a specified S.A.E. grade and blending of oils is avoided.

Pipelines

Pipe Line River Crossing.—N. Williams, in OIL AND GAS JOUR., vol. 33 (1935), No. 37, p. 33.

A novel method of laying a pipe line across a large creek is described. The usual practice has been to lay the first section on the bank, start this section across, the remaining sections being successively welded on until the entire crossing is made, whereupon this pipe would be allowed to sag to the bottom and is tied in with the ends on the two banks. An objection to this method is that the pipe under water cannot well adjust itself to the irregularities of the stream bed and that in dragging it into place the coating will be injured. In the present instance an accurate sounding of the stream was made at short intervals and plotted to scale. The stream section of the line was laid out on the bank, cold-bent exactly in conformity to the contour and wrapped; to protect the coating from injury when dragged into place it was protected by wooden laths wired lengthwise. This done, the section was dragged by a tractor across the stream with the assistance of floats made of empty oil drums and then allowed to sink into place. The wooden laths were left to rot away.

Transportation's Great Part in Iraq Construction.—J. F. Winchester in WORLD PETROLEUM, vol. 6 (1935), No. 2, pp. 65–68.

The construction of the Iraq pipe lines made severe demands on transport facilities, due to the magnitude of the job, the nature of the terrain and the climatic conditions. The trucks and tractors used were of various makes, which were variously adapted to the task in hand.

The six wheel Scammells had a very fine type of rear axle construction which enabled them to negotiate the lava country better than many of the others. The A.E.C. Hardys,

Colemans, Marmon-Herringtons and the Four Wheel Drives employed four or six wheel drives which gave them traction and certain advantages which the rear wheel drive vehicles did not possess. Certain types of vehicles were fitted with the Clayton Still type of radiator which was particularly adaptable to the severely hot climatic conditions encountered. The International-Harvester units were fitted with the Miller air filter which eventually became the standard type of air filter for all of the vehicles in operation. The fact that it draws the air through a fluid medium and has a large capacity for dirt made it an outstanding unit to handle the abrasive dust which would be drawn with the intake air into the engine. Steel bodies proved their superiority over wooden bodies, while the Westinghouse air brake system used on many of the American trucks proved its superiority over the best of mechanically operated brakes.

Petroleum Chemistry

Routine High-vacuum Distillation of Oils.—K. M. Watson and Charles Wirth, III, in IND. ENG. CHEM., Analyt. Ed., vol. 7 (1935), No. 1, pp. 72–75.

As the authors view the situation a generally standardized method for evaluating the boiling points of heavy oils is badly needed for the extension of both the practical and scientific aspects of petroleum technology. In addition to the importance of the boiling range as an indication of volatility, most of the difficult measurable physical properties of petroleum fractions are better correlated on the basis of boiling point than any other easily determined property.

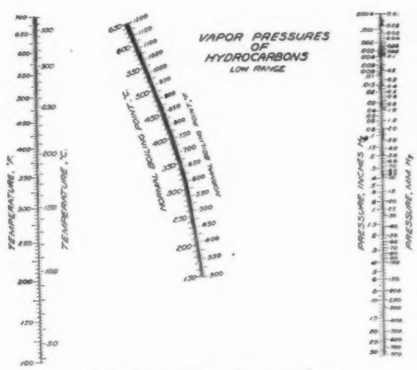


Figure 2. Boiling Point Conversion Chart

The apparatus devised by the authors for meeting this need is a modification of the Davis and Hornberg apparatus. (Nat. Petr. News, 1933, p. 65), which is characterized by the ample size of the vapor delivery tube and a method of connecting a McLeod gage direct to the distilling flask so as to avoid error due to pressure drop in the delivery tube. The authors have introduced the novelty of a trap cooled with liquid air or solid carbon dioxide to keep condensible vapors out of the gage.

In obtaining the entire boiling range of a material having an initial boiling point below 260° C. (500° F.) it is necessary to run an ordinary 100-cc. Engler distillation in conjunction with the vacuum distillation; the atmospheric distillation gives the lower and vacuum is used for the upper. The value of a high-vacuum distillation depends largely on the accuracy of the chart used for converting the observed temperatures to normal boiling points; the Coats and Brown chart for this conversion is regarded as the most logical and reliable, but is difficult to use. The authors therefore present the nomogram shown in the accompanying drawing.

Determination of Methane by Catalytic Oxidation.—I. F. Walker and B. E. Christensen, in IND. ENG. CHEM., Analyt. Ed., vol. 7 (1935), No. 1, pp. 9–11.

Catalytic oxidation offers a rapid, satisfactory method for the determination of methane in gas residues. Quantitative oxidation is obtained when the residue is twice passed over 3.5 cc. of cobalt oxide catalyst at a rate of 20–25 cc. per minute and a temperature of 550° C. followed by flushing at this temperature. The ratio of oxygen to methane should be at least 3 to 1. The authors recommend the use of two furnaces employing separate combustion tubes. The cobalt catalyst is made by evaporation and subsequent thermal decomposition of a solution containing 1.2 grams of Cu $(NO_3)_2$ .3 H_2O and 14 grams of CO $(NO_3)_2$ .6 H_2O on 40 grams of 10-mesh unglazed porcelain particles. Ethane and propane have no effect on the catalysis, but a slower velocity should be used when oxidizing butane. Traces of sulphur (1 to 100,000) are found to poison the catalyzer slowly.

Determination of the Aromatic Content of a Cracked Gasoline.—J. C. Vlugter, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 135, pp. 36–39.

For the determination of the aromatic content in cracked products, the actual determination by means of concentrated sulphuric acid is preceded by a selective hydrogenation of the olefines. This hydrogenation usually takes place at 300° C. under high hydrogen pressure in the presence of a specially prepared molybdenum catalyst. In extremely rare cases a disturbing polymerisation occurs during the course of this hydrogenation owing to very active olefines and diolefines, which necessitates a preliminary hydrogenation at a lower temperature with a nickel catalyst.

Polymerization of Liquid Hydrocarbons by the Electric Discharge.—G. Tarasov, in COMPTES. RENDUS ACAD. SCI. (Russian), vol. 4 (1934), pp. 401–403. REV. PETROL. No. 618 (1935), p. 212 (see following abstract).

A cracked kerosene with viscosities 2.88 at 20° and 1.68 at 50° C. was treated in a Siemens ozonizer with an electric discharge at frequencies of 350 to 2000 and voltages from 4 to 14 KV.

The results obtained show that, other conditions being equal, the viscosity increases with the duration of the operation, the increase being slow at first, then accelerating. For example, in one case the viscosity increased from 2.88 to 20.2 during four hours, reaching 66 in six hours and 178.7 in ten hours. The viscosity also increases with the strength of the current. From the results it appears that the optimum frequency is 500 periods per second. The temperature coefficient of the viscosity increases with the viscosity.

Crystallization of Paraffin.—R. Fussteig, in ALLGEMEINE OEL UND FETTZEIT., vol. 32 (1935), No. 1, pp. 32–36. (See following abstract.)

Paraffin as found in mineral oils has two crystal forms—the leaf form and the needle form; the leaf form is unstable and tends to pass into the needle form; the transformation is not reversible. The crude paraffin oil fraction crystallizes with difficulty because asphaltic constituents interfere with separation of the crystals, hence the practice of refining paraffin oil with fuming sulphuric acid. Even when thus treated there is difficulty in obtaining satisfactory crystallization when the oil is cooled, due to the tendency of both crystal forms to separate at the same time. For this reason the author recommends that the paraffin oil be separated into two fractions of sp. gr. 0.850–0.870 and 0.870–0.895. Crystallization in the separate fractions then proceeds more easily, with predominance of the needle form in both cases.

fig. 1

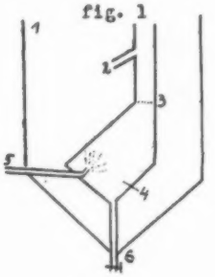
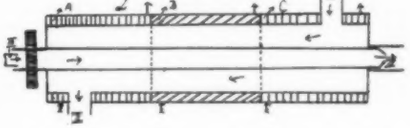


fig. 2



For obtaining large, easily filtering crystals, the following process is recommended; the paraffin oil, after refining with concentrated sulphuric acid is cooled to the point of crystallization. The leaf crystals which first appear in large quantity are transformed almost instantly into the needle form on addition of 0.1 percent (by volume) of a 10 percent solution of phenol in ethyl alcohol. The role of phenol here is to catalyze the transformation.

The author uses the same principle for analytically determining paraffin in the presence of asphalt and resinous matters: the sample is diluted with ethyl alcohol and butanone, and then a little phenol is added. The paraffin is precipitated quantitatively in easily filtrable form.

Progress in the Manufacture of Paraffin.—R. Fussteig, in PETROLEUM, vol. 31 (1935), No. 7, pp. 1–4 (see preceding abstract).

In this paper the author describes the practical application of his theories and discoveries to the separation of paraffin and oil. The old view that paraffin can exist in two forms—crystalline and amorphous—is incorrect; the apparent occurrence of an amorphous form is

due to the fact that asphaltic substances in the oil obstruct the crystallization of one of the two crystalline forms of paraffin. There are two ways of breaking up this association of asphalt and paraffin; one is by a cracking-distillation. The other is by treatment with concentrated sulphuric acid; the apparatus used by the author is indicated by the accompanying Fig. 1. In the ordinary agitator-tank 1 there is built in the vessel 4, which is filled to the level 3 with the concentrated sulphuric acid. This vessel 4 is furnished with a conical bottom and an outlet valve 6. The paraffin oil to be treated is injected into the oil through the spray 5, after passing through the acid the oil rises in the pipe above vessel 4 and falls into vessel 1 through the side opening 2.

The paraffin oil thus purified crystallizes first in the metastable leaf form. This is ascribed to the fact that on their first appearance the crystals are covered with an absorption layer of high-molecular hydrocarbons that are not removable by acid; in order to obtain the stable needle form this highly viscous layer must be destroyed by mixing with the mass 0.1 percent of its volume of a 10 percent phenol solution, which rapidly transforms the leaf crystals into needles.

In this process the manner of cooling the treated paraffin oil as a step in crystallization is of importance. A too rapid cooling tends to produce crystals that are too small for practical handling. The author is much in favor of a gradual or progressive cooling on the counter-current principle and in Fig. 2 gives a generalized sketch of a paraffin oil cooler. In this cooler the oil makes its entry at I and its exit at II. During its passage the oil is subjected to the cooling action of a brine (−3 deg. C.) which streams through the central brine-tube III; this tube is kept in constant rotation and is furnished with blades and scrapers to keep the crystallizing mass well stirred up. The entire crystallizer is surrounded by three separate cooling jackets A, B and C carrying brines at −3 deg., −6 deg., and −10 deg. C., respectively. The mass is then pumped to the wax press.

Estimation of Unsaturation in Aliphatic Hydrocarbons.—Samuel P. Mulliken and Reginald L. Wakeman, in IND. ENG. CHEM., Analyt. Ed., vol. 9 (1935), No. 7, p. 58.

Although there is no generally applicable method for the estimation of unsaturation in hydrocarbons the bromide-bromate method is one of the best and simplest. The authors have attempted to determine the limits of the applicability of this method and find that the bromide-bromate titration can be used with a fair degree of accuracy for the titration of most alkenes and also to determine the number of double bonds present in cycloalkenes and alkadienes, although less accurately for their quantitative estimation. Its application under ordinary conditions, in the presence of atmospheric oxygen, to alkines and to cycloalkadienes, such as terpenes, is of doubtful value.

Chemistry of "Voltols."—A Petrov and T. Bogoslovskaja, in COMPTES RENDUS ACAD. SCI. (Russian), vol. 394–397. REV. PETROL., No. 617 (1935), pp. 181. (See preceding abstract.)

The mechanism of "voltolization" (subjection of oils to the electrical discharge) comprises not only polymerization and condensing reactions, but also a cracking and a condensation of the cracked products. Kerosene and other fractions may be used as raw materials. Olefines give the best yields of polymers (60 percent); next are the naphthenes and paraffinic hydrocarbons (23–28 percent) and then the aromatic hydrocarbons (15 percent). As regards the absolute viscosities of the products the order is reversed, but the paraffines and olefines yield products with the best viscosity indices.

The high viscosities of the oils is due to the polycyclic polymers arising from the aromatic and naphthenic series; the paraffins and olefins play the role of solvents and are not able to produce oils of very high viscosity. For this reason it is necessary to add aromatics and naphthenes to them before voltolization. By varying these additions it is possible to produce oils of any desired viscosity or viscosity index, with a larger or smaller input of electric energy, but the energy required is less the greater the molecular weight of the initial product, and the greater the content of aromatics and naphthenes. On the other hand the viscosity index becomes less favorable as the proportion of aromatics and naphthenes is increased. The optimum product is therefore represented by the intersection of two curves: (1) the decrease of electrical input for each degree of increase of viscosity as a function of the initial content of aromatics and naphthenes, and (2) variation of the viscosity index referred to the same initial content.

Molecular Weight of Cracked Distillates.—Ogden Fitz Simmons and E. W. Thiele, in IND. ENG. CHEM., vol. 7 (1935), No. 1, pp. 11–14.

Molecular weights are important properties of petroleum products and are of much significance in the design of petroleum equipment. The authors have previously worked out a simple method for this determination as applied to straight run stocks, and now extend the method to cracked distillates. The procedure is expeditious and when the results are correlated with boiling point, viscosity and density the estimation of any given cracked stock is simplified.

Petroleum Physics

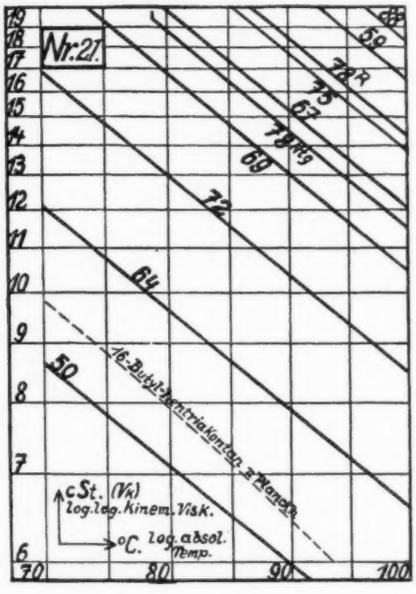
Theory of the Engler-Ubbelohde Boiling Curve.—E. L. Lederer, in PETROLEUM ZEITSCHRIFT, vol. 31 (1935), No. 7, pp. 1–12.

For many years practical use has been made of the Engler boiling curve (mostly in the Ubbelohde modification) for the investigation of hydrocarbon mixtures, but there seems to be lacking a systematic theoretical basis that would allow an investigator to get from such curves all the information they are capable of giving. The author here undertakes to supply such a basis. In the first place all boiling curves are classified into various types according to whether they are derived from pure liquids or mixed liquids having distinct characteristics, and for each of which an equation is derived showing the units of distillate in percent of total volume as a function of temperature. The differential quotients of the boiling curves are used to obtain a correct picture of the distribution of the various components.

By the author's method, the applicability of which is supported by extensive experimental data, it is possible to differentiate cracked gasoline from stripped gasoline, and to some extent to draw conclusions as to the geological history of a crude oil.

Viscosity, Its Basis, Measurement and Significance.—Leo Ivanovzky, in PETROLEUM, vol. 31 (1935), No. 2, pp. 1–12.

This investigation relates principally to solid hydrocarbons such as ozokerite, paraffin, ceresin and other mineral waxes, using a slightly modified Steiner viscosimeter. The general character of the results is indicated in the accompanying diagram, which shows the viscosity-temperature relations of assorted solid hydrocarbons. Abscissae are log absolute temperature in Centigrade degrees and ordinates are centistokes reduced to log log kinematic viscosities. The broken line is the



graph of 16-Butyl-hentriakontan of Planck. Line 88 represents Roumanian crude ozokerite; 59, American crude petrolatum; 78 R, Russian crude ozokerite; 75, superlawax; 67, acid treated American petrolatum; 78 ntg, natural yellow ozokerite from Russian mineral wax; 69, double refined ozokerite from Russian mineral wax; 72, natural yellow Polish mineral wax; 64, Indian plate paraffin; 50, plate paraffin from Russian crude petroleum.

The advantage of using log logs of the kinematic viscosities for ordinates and log temperatures for abscissaes is that practically straight lines are obtained, which permits interpolations and even extrapolations. The lines for the solid hydrocarbons are practically parallel, so that the whole curve may be drawn by determination of a single point.

Physical and Thermal Properties of a Crude Oil.—H. Sage, W. N. Lacey and J. G. Schaafsma, in IND. ENG. CHEM., vol. 27 (1935), No. 2, pp. 162–165.

Continuing the investigations that have been prosecuted on phase equilibria in hydro-

carbon systems at the Calif. Inst. of Technology, the authors have studied the physical and thermal properties of a Kettleman crude oil and have evolved methods of calculating energy lost in a pumping oil well operation. It is part of the Research Project 37 of the A.P.I.

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Petroleum Products

LIQUIFIED GASES AS MOTOR FUEL.—K. Hopfer, in OL UND KOHLE, vol. 2 (1934), No. 13, pp. 557–559.

Compressed propane and butane have given satisfactory results in omnibus operation in Germany. A 42-passenger bus operating in hilly territory consumes about 38 to 40 kilograms of butane per 100 kilometers (84 to 88 lbs. for 66 miles); these amounts of butane give 430,000 to 450,000 heat units as compared with 500,000 heat units of gasoline consumed in the same service, which means an economy of 10 to 15 percent in the quantity of fuel used. The fuel is carried in steel flasks of about 55 gal. capacity and tested at 225 lbs. per sq. in. One tank filling for a 60 H.P. truck motor is good for a cruise of 300 km. (about 200 miles).

STORAGE STABILITY OF CRACKED GASOLINE.—C. G. Dryer, J. C. Morrell, G. Egloff and C. D. Lowry, Jr., in IND. ENG. CHEM., vol. 27 (1934), No. 1, pp. 15–20.

This contribution from the laboratory of the Universal Oil Products Co. deals with storage stability as related to induction period and critical oxidation potential. In storage cracked gasoline at first changes slowly, forming a small amount of gum (air-jet) and a low concentration of peroxides. After a time formation of peroxides and gum increases quite suddenly, accompanied by a sharp rise in copper-dish gum, dark color and loss of octane rating. The formation of 10 mg. of air-jet gum usually denotes that the period of slow change or "storage induction period" is nearly over, and 15 mg. marks the beginning of rapid change.

The storage life of gasolines of different origins, measured by the time required to form 10 mg. of air-jet gum, cannot always be predicted from the initial induction period. When comparison was made of the samples of the same gasoline stored alone and after addition of inhibitors, the induction periods could be correlated with storage life; and with all but one of the gasolines studied, a given induction period corresponded to about the same storage life.

Increase in induction period produced by an inhibitor is sometimes of more significance in determining storage ability than the total induction period possessed by an inhibited gasoline. In all cases studied, gasolines in which the original induction periods had been increased 200 minutes by use of an inhibitor, proved stable in storage for more than a year, and some in which the increase was 150 minutes were stable for this period.

In many gasolines an induction period of 300 minutes assures storage stability under laboratory conditions for longer than one year.

The critical oxidation potential of an inhibitor is related to its antioxidant power but is not an exact index of its efficacy.

In predicting storage stability, induction period appears the most reliable single test. High copper-dish gum in some cases accompanies instability in storage, while increase in copper-dish gum and in peroxide number during the early part of a storage period denotes approaching deterioration in other respects, particularly formation of air-jet gum.

OIL ECONOMY AND RECOVERY OF OLD OIL.—Hans Steinbrecher, in OL UND KOHLE, vol. 2 (1934), No. 2, pp. 590–592.

In a country having little native petroleum and a scarcity of foreign exchange with which to purchase foreign supplies, it is not surprising to find large users of oil exercising economies in ways hardly thought of in countries where wasteful habits are ingrained. The author describes the oil economy of a large German mining company. In the first place lubrication throughout the works is put in charge of a trained mechanical engineer who is given carte blanche in the matter of experimentation and control of the oilers, with instructions to make the widest possible use of cheap materials and substitutes. One highly satisfactory substitute for the oil used in the machine shops is an emulsion of cylinder oil with 95 percent of its weight of lime water. The greatest care is exercised to collect and regenerate all used oil. This practice is even carried to the extent of persuading the railroads to turn over all discarded oil waste removed from the journal boxes; the oil is extracted by solvents and the clean waste returned to the railroads. The fullers earth used in treating old machine and transformer oil is also extracted with solvents. By these various measures this extensive work has reduced its oil bill by 75 per cent.

CRACKING GAS IN TINPLATE MANUFACTURE.—W. N. Hoyte, in PETROL. TIMES, vol. 32 (1934), No. 830, pp. 629–630.

In British tinplate works where the use of coal fuel or producer gas was formerly considered indispensable it was found practicable to substitute dry cracking gas from oil refineries, with superior results.

TECHNICAL RECOVERY OF VOLATILE SOLVENTS.—Erich Boye, in CHEM. ZTG., vol. 58 (1934), No. 101, pp. 1017–1020.

A useful review, with numerous references to the patent literature, of processes for recovering solvent vapors. The processes treated include absorption in heavy liquids, and by carbons and silica gel.

UTILIZATION OF PARAFFIN WAX AND PETROLEUM CERESIN.—P. G. Higgs, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 135, pp. 1–14.

This is a somewhat extended account of the modern uses of petroleum waxes, with special reference to the match industry, the waterproofing of various commercial materials, and for electrical purposes. Each use imposes conditions which the physical characteristics of the wax must meet. Petroleum ceresins are distinguishable from paraffins by their relatively high setting point and their microcrystalline structure. They are usually nondistillates and are generally separated by volatile solvents. Petroleum ceresins have now become commercial products, filling a place not fully occupied by the more common paraffins; some East Indian products have setting points as high as 93° C., and can be used as a substitute for hard natural waxes, such as carnauba; and it is valuable for electrical purposes. Blends of these hard ceresins with commercial paraffins have some interesting and valuable properties. The color of ceresins is not generally a bar to their many uses.

Petroleum Substitutes

MOTOR FUEL FROM CRACKED BROWN COAL TAR.—Karl Kohlhardt, in OL UND KOHLE, vol. 11 (1935), No. 5, pp. 80–83.

The lack of adequate petroleum supplies and the scarcity of foreign exchange have forced the German chemical technologists to study all means of obtaining substitutes. The author shows in this article that the problem of obtaining gasoline from brown coal tar has now been solved from both the technical and the economic standpoints. Yields per 100 kg. of tar are given as follows:

Gasoline	35.2 kg.
Diesel Oil	1.3 "
Phenol	1.2 "
Cresol	1.5 "
Pitch	44.0 "
Gas	13.0 "
Water and loss	3.8 "

The process is practicable even in small and medium sized plants.

ALCOHOL—MIXED FUELS.—By J. Kostler; published 1934 by Oesterreichisches Petroleum Institut (Austrian Petroleum Institute); 30 pp.

This is a collection of literature references to the use of alcohol in motor fuels. The subject is considered under the following heads: General considerations, ethyl alcohol, alcohol fuels, alcohol-hydro-carbon mixtures and their stabilities, preparation and manipulation, gasification (evaporation), combustion, consumption in comparison with gasoline, motor performance in comparison with gasoline. There are 140 literature references.

SYNTHETIC FUELS AND LUBRICANTS.—M. Pier, in CHEM. ZTG., vol. 59 (1935), No. 3, pp. 37–38.

The progress of obtaining lubricating oil from distillation products of German brown coal has now passed through the laboratory stage; the yield is 20 percent of the crude product worked, the rest being gas oil, or gasoline and paraffin. The I. G. Farbenindustrie, has lately perfected a process for dehydrating and polymerizing paraffin to produce excellent lubricating oils and special oils, and flow-point improvers equal to "Paraflow." This opens new supplies of lubricants from German raw materials. In short, the "inventive genius of German chemists" has made it possible to ob-

tain all necessary mineral oil products from coal, even from hard coal. Reference is made to a pilot plant that has been operating since Sept. 9, using 20 tons of brown coal per day; 94 percent of the carbon of the coal is converted into 14 tons of liquid petroleum, the rest into gas containing 30 to 40 percent of propane and butane. Hard coal is successfully worked also; this kind of coal gives the heavier hydrocarbons. It seems now that both brown coal and hard coal can be completely hydrogenated, thus avoiding production of large quantities of by-product coke.

Petroleum Economics

THE STOCK MARKET FOR OIL SHARES, 1934.—Oskar Tokayer, in PETR. PRESS SERVICE, vol. 2 (1935), No. 2, pp. 6–8.

The year 1934 has been full of disappointments for oil share holders, quotations have more or less heavily declined on all the stock exchanges of the world. Unfavorable conditions were especially numerous during the second half of the year, and were worst at about the close. Among these depressing circumstances are listed the continuous overproduction of crude oil, the imminent competition of Iraq oil on the world markets, the growing disharmony between the United States Oil Administration and executives of the oil industry, price wars, and the increasing tendency of several consuming countries toward self-sufficiency. Some favorable factors, such as increasing world consumption and the improved statistical position of American oil markets, have not been sufficient to overbalance the unfavorable stock market factors.

The accompanying table of price indexes for oil shares on the various stock exchanges shows to what extent the quotations of stock in the principal oil companies have declined (1927 index=100).

	New York	London	Paris	Brussels	Amsterdam	Berlin
End 1933	47.82	74.20	35.80	37.82	52.89	75.52
End 1934	44.12	61.03	27.02	28.79	40.65	72.20
End June 1934	47.08	67.55	33.32	35.09	49.45	86.46
Mid-Oct. 1934	40.22	67.06	29.48	31.85	45.16	77.53
End Oct. 1934	41.17	65.44	25.62	30.92	44.32	75.27
Mid-Nov. 1934	44.27	62.82	25.34	30.02	41.80	71.12
End Nov. 1934	44.10	62.92	25.83	28.48	42.19	73.47
Mid-Dec. 1934	41.60	61.42	25.69	30.18	41.24	71.66
End Dec. 1934	44.12	61.03	27.02	28.79	40.65	72.20

CAPITAL AND PROFITS OF ROUMANIAN OIL COMPANIES.—Anon, MON. PETROLE ROUMAIN, vol. 36 (1935), No. 3, pp. 141–151.

This is a detailed analysis of the capital structures and profits of incorporated companies operating in the Roumanian oil fields. The general picture shows that with production now at a peak and with a correspondingly increased volume of exportation, the financial position of the industry has not only shown no improvement but has actually retrograded. The necessity for increasing production has required new investments for drilling, storage and refining facilities, etc., and a fall in prices has coincided with a rise in taxation. The result is that, according to latest balance sheets, only four of the companies have been able to pay a dividend. These four include concerns that operate refineries; some of the enterprises that operate natural gas wells have registered a little profit, but all other groups have shown losses, and are finding it difficult to obtain credits. A goodly number of companies are reducing their capital in some cases as much as two thirds.

SYMPOSIUM ON PETROLEUM ECONOMICS.—J. C. Chatfield in NATL. PETROL. NEWS, vol. 27 (1935), No. 9, pp. 27–28.

This is a summary of current petroleum economics as viewed by mechanical engineers at the recent meeting of the A.I.M.M. From a study which correlated gasoline consumption with business conditions, automobile registrations and consumption per car, it is concluded that motor fuel consumption has reestablished its former long-time trend. The effect of the depression on motor fuels was to lose permanently about three years of normal growth. Motor fuel consumption in 1935 will be approximately 425,000,000 bbl., as compared with 406,269,000 bbl. in 1934. Consumption in the U. S. during the past four years has been greater than new discoveries and great new fields are not in sight. One of the evils afflicting the industry is collective leadership by which major errors are committed; errors committed by individual leadership would cancel each other. Another and greater evil is the law of capture, which the industry has sought to palliate, instead of making a concerted attack upon it. Proration is a device by which it has been attempted to mitigate the evils of the law of capture, but proration has increased rather than decreased pressure on the markets, especially because it has driven the oil companies to build up retail outlets in order to hold their share of the demand. The code has also contributed to expansion of marketing by increasing resellers' margins. Nationalization of the industry is not regarded as a cure for its ills. During the past five years the U. S. has reduced its storage by about 136,595,000 bbl., whereas in the same period the rest of the world has added 343,745,000 bbl. to storage (much of which is doubtless war reserve. ED.).

TANKER TRANSPORT OUTLOOK.—Oskar Tokayer, in PETROL. PRESS SERVICE, vol. 2 (1935), No. 2, p. 9.

In many respects 1934 has been an eventful year for the tanker freight market. At the beginning of the year rates were at the lowest level for many years; there was a revival in the spring, due mainly to increased chartering by the big companies and to the formation of the Tanker Pool. The results achieved by the Pool exceeded expectations for a time, but toward the end of the year rates again weakened, and the outlook is fairly dark. The big companies are launching new tonnage that will have increased speed and therefore greater carrying capacity. New fields in the Near East will decrease the average haul and thus again increase the carrying capacity of existing tonnage. The same result is following the erection of European refineries, which shortens the haul for finished products.

At the present time many owners, faced with a freight situation far from encouraging, are glad to take advantage of the option afforded by the Pool of receiving some slight payment in return for laying up their ships, but the only real solution for the difficulties of the tanker freight market lies in the scrapping of all old and out-of-date vessels. Whilst the owners of such vessels can never again hope to earn a proper return from them, their mere existence will be sufficient to prevent the trade from receiving benefit which should follow from the increased world demand for oil products.

Books

THE GASOLINE TAX IN THE UNITED STATES IN 1934, by Finla G. Crawford; published 1934 by Public Administration Service, Chicago; 46 pp. double column; 50 cents.

After a review of the motor-fuel tax laws of all the 48 states and the District of Columbia, and much other material, the author reaches the unavoidable conclusion that the relation between price and tax is out of proportion. Fully a third of the average motorist's gasoline dollar is now absorbed by single or multiple local, state, country and federal taxes. In one state these taxes amount to as much as 11 cents per gallon. The booklet gives an excellent summary of the situation.

OIL AND GAS GEOLOGY OF THE GULF COASTAL PLAIN IN ARKANSAS, by W. C. Spooner, with a chapter on upper Cretaceous Ostracoda by Merle C. Israelsky; 516 pages, 26 plates, 95 figures, 57 charts and tables. Privately printed (1935), by Parke-Harper Printing Co., Little Rock, Ark. $3.80.

This book is a welcome contribution to the geology of one of the more important oil regions of the United States. It is the fruit of labor begun by the author in 1927 in connection with the Arkansas Geological Survey under George C. Branner. Notwithstanding the fact that between 1922 and 1931 the State of Arkansas and its political subdivisions have collected at least $17,000,000 in taxes from the oil industry, the state geological survey had no funds for publishing this important work, and that it now sees the light is due to the acumen of the Parke-Harper Company, who found it worth their while to publish it at their own risk.

The work is admirably conceived and executed. The general stratigraphy is fully and lucidly described, and the structures and characteristics of each individual oil field, of which 14 are now producing, are given in satisfactory detail; and to elucidate further oil and gas possibilities of the region, the structure and stratigraphy of each of the 46 separate counties of the Gulf Coastal Plain are again summarized. There is a copious index. The publishers are to be commended both for their enterprise and for their care and good taste in the printing and binding.

Foreign Oil Legion

B. H. Van der Linden

B. H. Van der Linden, head of the drilling and production department of the Royal-Dutch Shell Group photographed by the editor of World Petroleum at the Hague holding the famous fossilized shell (Pecten Andersonii) used as a model for the Sign of the Shell throughout the world. Mr. Van der Linden found this shell in the Coalinga beds in California where he went in 1913 from Netherland India. In California Mr. Van der Linden acted as chief geologist of California Oilfields Ltd., then owned by Balfour Guthrie and Co., later becoming Shell Petroleum Co. in 1915. Mr. Van der Linden returned to the Hague in 1922.

Mr. Van der Linden is now *en route* to the United States from the Hague and plans to visit some of the California fields.

Professor Umberto Puppini has been nominated to the presidency of Azienda Generale Italiana Petroli, succeeding the Honorable Allessandro Martelli.

The career of Prof. Puppini has been a brilliant one. Born in 1884, in Bologna, he entered the School of Mines of his native city and later became professor of agricultural hydraulics and director of the Superior School of Industrial Chemistry in the same city.

In 1914 he won the "Francolin" prize offered by the Italian Society of Architects and Engineers for his hydraulic investigations, and in 1915 the Boileau prize bestowed by the Paris Academy of Sciences.

The new president of the A.G.I.P. was named Under-Secretary of Finance in 1932, and Minister of Communications in 1934, a function which he has now left to devote himself to petroleum.

In an interview with Professor A. N. Sachanen, former consulting engineer of Goyusneft, the professor stated:

As of today Baku oil fields are the mainstay of Soviet crude production. Baku oil fields have produced in 1934 almost 80 percent of the total for all Soviet fields and have thus checkmated the decline of Grozni as well as the slow development of all Soviet oil fields outside the Caucasus. The Baku oil fields have enabled the Soviet oil industry to increase the showings of crude production in 1934 over 1933. However, the sporadic and drastic progress of Baku against the slow development of all other Soviet oil fields is, undoubtedly, bound to bring a calamity. It has to be remembered that the region of Baku oil fields is comparatively limited and the resources are not inexhaustible. The Baku oil fields were under operation continuously for several scores of years.

Judged from the daily average output of crude production aggregating at present about 360,000 bbl. the oil fields of Baku rank second to Oklahoma or California (about 500,000 bbl. per day each), only the potentials of both U. S. fields are considerably higher in many ways. The new districts of Baku which were only recently opened for production (Kara Chukhur, Kala, Lokbatan) are yielding today about 20 percent of the total output of all Baku oil fields and are to be considered the most successful development of the region. Other adjacent districts of Azerbaidzan were also explored, prospected and wildcatted, but have failed to fall in line, which tends to show that not all districts of Baku are rich oil bearing lands.

The Grozni oil fields in their original or basic form have been declining since 1930 when the daily average amounted to 155,000 bbl. of crude. The present daily output of Grozni aggregates 50,000 bbl. and so far there are practically no positive indications that any other regions of Grozni outside of the old and new oil fields will yield production of appreciable commercial value. There are, likewise, no positive signs to the effect that the lower depths of the existing oil fields at old and new Grozni are commercially productive.

Production at Maikop has been on the upgrade, but this oil field will never equal Grozni in importance owing to the irregular nature of the geological formations and strata and the anomalies of the oil bearing layers. Emba oil fields have great potential value, its hundreds

(Continued on page 257)

A. N. Sachanen

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World Oil Production—Official Figures for 1934 Revised

All figures furnished direct to WORLD PETROLEUM by Governments, except where otherwise specified

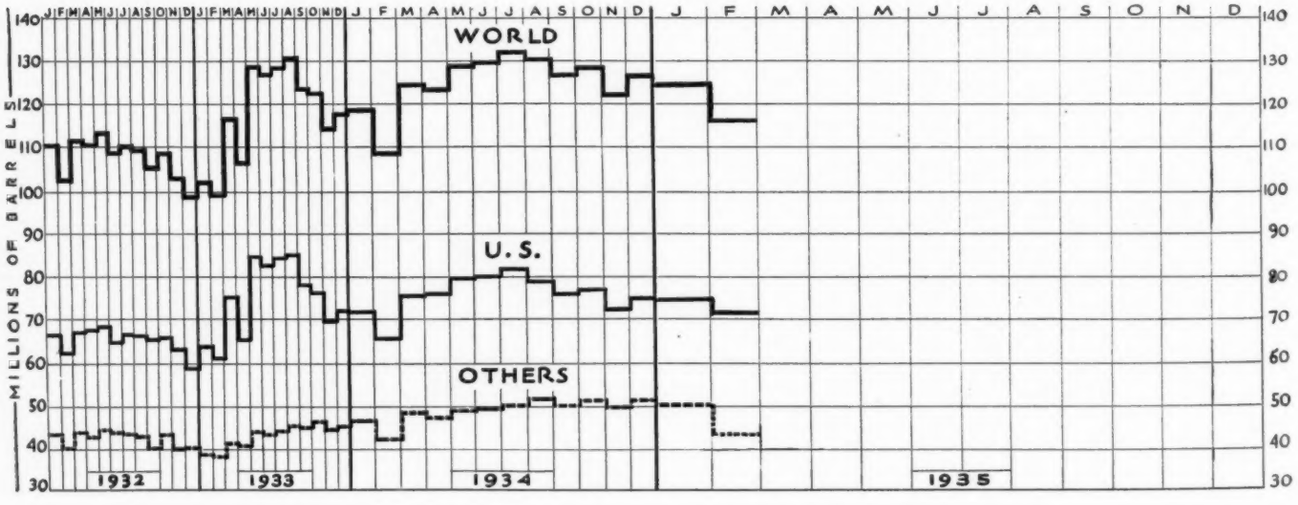
(Figures in U. S. Barrels—Conversion ratio 7 bbl. = 1 ton)

Country	March 1934	April 1934	May 1934	June 1934	July 1934	August 1934	September 1934	October 1934	November 1934	December 1934	January 1935	February 1935
United States	75,548,000	75,796,000	79,870,000	80,040,000	81,548,000	79,058,000	75,810,000	76,776,000	72,463,000	74,772,000	78,715,000	72,800,000[1]
Russia	14,644,000	14,081,900	14,315,000	13,966,400	14,297,500	14,287,700	13,924,400	14,260,000	14,388,500	14,638,400	13,358,100	12,035,000[1]
Venezuela	11,238,717	11,185,076	11,768,799	12,500,307	12,193,307	12,505,304	12,381,159	12,591,390	12,274,794	12,420,296	12,818,414	11,900,000[1]
Roumania	5,066,000	4,981,000	5,008,000	5,178,000	5,223,000	5,556,000	5,335,000	5,467,000	5,324,000	5,522,000	5,355,000	4,865,000[1]
Iran[2]	4,483,535	4,284,231	4,648,105	4,401,223	4,577,251	4,886,462	4,955,419	4,499,530	3,725,178	4,049,556	4,410,714	4,109,665
Mexico	3,183,923	3,206,490	2,714,828	2,918,793	3,303,055	3,434,516	3,276,612	3,393,770	3,332,926	3,425,314	2,405,994	2,662,261
Netherland India	3,631,726	3,489,024	3,609,816	3,577,056	3,678,745	3,456,215	3,410,785	3,577,399	3,553,067	3,743,810	3,716,300	2,630,642
Colombia[4]	1,017,147	1,193,736	1,730,095	1,683,691	1,646,739	1,691,314	1,627,632	1,646,293	1,633,654	1,554,172	1,653,647	1,141,696
Argentina	1,231,978	1,128,922	1,029,074	1,096,855	1,077,502	1,210,273	1,258,812	1,271,186	1,283,811	1,173,998	1,125,000[1]	1,002,000[1]
Peru[4]	1,086,827	1,037,127	1,085,192	1,187,030	1,233,804	1,300,253	1,259,901	1,303,554	1,169,826	1,250,247	1,248,465	1,105,508
Trinidad	876,544	876,950	926,785	947,122	1,008,669	975,697	919,469	906,152	907,653	930,877	915,220	843,619
British India	808,647	759,977	796,208	749,294	785,751	762,959	752,451	700,000[1]	700,000[1]	700,000[1]	700,000[1]	700,000[1]
Poland	310,800	304,500	305,592	304,437	315,861	320,145	311,003	315,000	308,000	308,000	307,000[1]	297,000[1]
Sarawak	176,568	166,999	166,565	158,669	164,206	161,504	155,400	156,800	152,600	158,200	183,300	136,500
Japan	122,488	118,770	126,170	125,202	131,397	129,326	124,870	125,229	119,970	131,059	171,441	183,000
Egypt	121,121	117,236	130,851	132,097	135,156	131,061	124,502	123,235	116,326	115,731	112,000[1]	107,000[1]
Ecuador	131,566	135,226	142,869	158,826	141,474	140,944	136,033	141,079	133,490	140,000	147,315	139,555
Canada	130,046	118,890	117,693	109,021	120,772	114,778	114,242	122,056	113,228	117,113	124,654	113,000[1]
Germany[3]	159,096	176,071	159,103	179,480	208,145	219,961	198,366	227,605	219,485	228,767	287,518	256,000[1]
Iraq[5]	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	337,000	1,054,599	425,000	650,000[1]
France[1]	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	26,000
Others[1]	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Total	124,189,729	123,379,125	128,871,745	129,634,503	132,011,334	130,563,412	126,297,056	127,824,278	122,397,510	126,555,139	128,301,082	117,778,449

[1]Estimate. [2]Anglo-Persian Oil Co. figures revised; fuel oil returned to the ground has been deducted. [3]Thuringia estimated 7,000 bbl.; official figure for Prussia. Russian Sakhalin included with Russia. Japanese Sakhalin included with Japan. [4]International Petroleum Company's figures. [5]Iraq production estimated to November 1934; represented by oil shipments through Tripoli and Haifa starting in November.

Official Crude Oil Production Figures for 1934 and 1935

	Total 1935 (Jan. and Feb.)	Daily Average 1935	Total 1934	Daily Average 1934
United States	151,515,000	2,568,051	909,107,000	2,490,704
Russia	25,393,100	430,391	168,648,700	462,051
Venezuela	24,718,414	418,956	142,072,329	389,239
Roumania	10,220,000	173,220	62,006,000	169,879
Iran	8,520,379	144,413	52,663,782	144,284
Mexico	5,068,255	85,903	38,167,022	104,567
Netherland India	6,346,942	107,575	42,289,408	115,861
Colombia	2,795,343	47,379	17,340,724	47,509
Argentina	2,127,000	36,051	14,115,360	38,672
Peru	2,353,973	39,898	14,143,959	38,751
Trinidad	1,758,839	29,811	10,894,363	29,847
British India	1,400,000	23,729	8,997,399	24,650
Poland	604,000	10,237	3,697,617	10,130
Sarawak	319,800	5,420	1,948,044	5,337
Japan	354,441	6,007	1,484,962	4,068
Egypt	219,000	3,712	1,479,037	4,052
Ecuador	286,870	4,862	1,655,062	4,534
Canada	237,654	4,028	1,418,810	3,687
Germany	543,518	9,212	2,266,964	6,211
Iraq	1,075,000	18,221	2,411,599	6,607
France	72,000	1,220	552,000	1,512
Others	150,000	2,542	861,000	2,359
	246,079,528	4,170,839	1,498,221,141	4,104,715



World crude oil production in barrels by months, 1932–1935: Ratio of United States crude production to production in all other countries.

MEXICO

FOLLOWING the same short sighted policy that has so drastically reduced Mexico's petroleum production and industrial importance during the past few years, the administration announces that Mexican Eagle must pay the Mexican treasury 7,500,000 pesos ($2,100,000 U. S.) to cover import duties unpaid under the provisions of the concession originally granted to Pearson and Son in 1906, since taken over by Mexican Eagle. This concession stipulated that petroleum machinery could be imported duty free but the concession was cancelled in January of this year.

Mexican Eagle must also pay in cash, instead of in public debt bonds as stipulated in the contract, a further 11,000,000 pesos ($2,500,000 U. S.) within ten years.

Congress ordered cancellation of the franchises to the oil lands and the rights to import oil machinery, etc., duty free on ground that these privileges violated the national constitution which forbids monopolies. Action was approved by President Cardenas, and the measure became a law on February 4.

As the 1935 federal budget does not provide for use of the 7,500,000 pesos Eagle must pay this year, ministry announces the money will be devoted to public works.

Huasteca Petroleum Company (Standard of Indiana) has been ordered by the Federal Board of Arbitration and Conciliation to pay employees of its Mata Redonda unit in Tamaulipas wages covering the duration of the employees' strike which lasted from January 23 to March 9. This would consist of a total indemnification of 300,000 pesos ($84,000 U. S.). The company's appeal to the Tamaulipas district court for an injunction has been denied.

Meanwhile difficulties in the operation of Mexico's own petroleum company are coming to light.

Twenty-six former employees of Administrative Control of National Petroleum, federal government agency that was recently merged with Cia. de Petroleos de Mexico, S.A. (PETROMEX), semi-official company organized by the national administration to engage in all branches of the petroleum industry, as part of government's contribution to 50 per cent of Petromex's capital, are suing Petromex before federal conciliation and arbitration board for alleged unjustified dismissal and pay for the last week in January. Claimants say they were dismissed without cause when Control was consolidated with Petromex.

Petromex has established a terminal in Mexico City for distributing gasoline, kerosene and engine and boiler fuel at current Mexico City market prices.

Vera Cruz state won another point in its litigation, involving 18,085,000 pesos (some $5,000,100, U. S.), which it claims as costs and interests, against Transcontinental Oil Co.; Northern Petroleum Co.; Agwi Refining Co.; Mexican Dutch Corona Petroleum Co. (Royal Dutch Shell), and Capuchinas Petroleum Co., when the federal supreme court dismissed these companies' suits for an injunction against enforcement by Vera Cruz of an embargo on well Amatlan No. 4 in Lot 176, Amatlan zone, Vera Cruz. The court disagreed with plaintiffs' contention that Vera Cruz had violated the national constitution by invading federal jurisdiction in embargoing the well, action which it took in connection with tax and other claims against companies.

The companies have pointed out that lifting of the embargo was imperative as the well would probably go to salt water if its operation and that of its machinery is not attended by experts.

Ministry of communications and public works announces that it has decided to cancel a concession long held by Mexican Gulf Oil Co. to operate a toll road between the La Puntilla bridge, Tampico, and its terminal, as it was found that the collection of a toll from each vehicle using the road inconveniences the public.

Stories by Mexico City daily newspapers to the effect that the Mexican government and people were roundly criticized at the meeting in London of shareholders of Mexican Eagle Oil Co. are denied by J. A. Assheton, president and managing director of the company.

DOUGLAS GRAHAME

CANADA

Imports of Crude

IMPORTS of crude into Canada during the first month of this year totalled 59,948,284 gallons valued at $1,714,991, which was an increase of a little over 2,000,000 gallons from January 1934, and over 12,000,000 gallons from December 1934. Some 44,871,048 gallons, valued at $1,394,332 originated from the United States; 7,330,436 gallons from Peru, and 7,746,800 gallons from Venezuela.

Miscellaneous

THE annual report of Home Oil Company for 1934 showed a substantial reduction in the company's loss from operations. Net loss in 1934 totalled $6,465 as against $25,587 in 1933 although net operating earnings were lower. Expenses were greatly reduced. Under accounts receivable is shown $380,410 due from Royalite Oil, representing the value of 18,333 shares of Royalite Oil at $20 per share plus a dividend of 75 cents per share. Home Oil is now in the oil business only as a shareholder of Royalite Oil.

Ajax Oil and Gas Company reported net profit for the 1934 fiscal period of $50,318 as compared with $41,936 in 1933. Earnings from operations, however, were lower, and the company did not earn its dividend distribution of eight cents per share which was disbursed to shareholders. The annual report also shows that the deficit in working capital account increased from $14,024 at the end of 1933 to $77,297 at the end of 1934. Current liabilities at the end of the year were $118,646, and current assets $41,349. Demand loans increased from $18,000 to $73,000.

THE well of Franco Oils in southern Alberta is now down to 2,100 ft., with 13-inch casing being carried down behind the tool.

A second well was spudded in during February by Amalgamated Gas and Oil Company at its property near Hudson Bay Junction. The first well struck gas at 277 ft., reported to flow at between 200,000 and 300,000 cubic ft. per day, and the second well is 1,000 ft. from the first. The first well has been capped and further drilling to determine structure will be undertaken.

Max W. Ball, petroleum engineer, is completing plans to erect a plant capable of separating 250 tons of bituminous sands daily. Present plans are to the effect that the new plant will be in operation by September 1936. Exclusive rights have been granted Max Ball for three years in the Horse River Federal Reserve near Fort McMurray. The tar sands separation plant, and also a refinery, will cost in the neighborhood of $250,000, it is reported.

A NEW petroleum refining plant, costing $250,000, will be started next fall at Burnaby. This plant is to be built by Dent, Limited, a newly formed Vancouver Company.

R. C. ROWE

U. S. S. R.

Official Figures for Soviet Oil Operations

1935	Crude Production (bbl.)	Daily Average (bbl.)	Run to Stills (bbl.)	Drilling (feet)
January	13,358,100	430,935	11,400,000	248,672
February	11,850,000	423,000	10,200,000	231,000
Total	25,208,100	427,000	21,600,000	479,672
Total 2 mos. 1934	25,844,000	438,000	22,301,000	638,520
Total 1934	168,648,700	458,042	145,141,000	4,122,898
Total 1933	149,901,000	407,096	131,591,300	2,789,253
Quota 1934	214,900,000	588,876	161,000,000	4,950,000
Quota 1933	170,800,000	467,670	155,000,000	3,315,000
Quota 1935	232,400,000*	636,700	171,500,000	5,214,000

*Including gas: crude except gas = 198,800,000 bbl.
Crude conversion, seven bbl. = one ton.

CRUDE production continues to lag behind plan. This is, however, not unusual for Soviet oil operations at this time of the year when adverse weather conditions are not favorable for expansion. It is to be expected that better results will be obtained when spring weather sets in.

The daily average of crude production for all Soviet oil fields aggregates about 446,000 bbl. which almost equal the corresponding figure for the first quarter of last year.

Daily Average Crude Production Major Oil Fields

	1935	Third Quarter 1934	First Quarter 1934
Baku	364,000	365,000	354,000
Grozni	49,200	60,000	63,000
Maikop	21,000	18,000	17,500
All other	12,230	22,000	19,500
Total	446,300	465,000	454,030

M. Barinoff, head of Glavneft has commented in a recent issue of ZA INDUSTRIALIZATION on the Soviet oil resources which Acad. I. Gubkin estimates at 21,000,000,000 bbl. and feels that this figure has to be augmented considerably by taking into consideration all visible and possible deposits discovered in recent years on the Volga and in Siberia. M. Barinoff suggests a revision of the estimate and shifting the visible and possible deposits into a higher rank of immediately available resources and to begin immediately their development.

An analysis of present crude production and planned expansions during the second Piatiletka reveals that prospecting and exploration which are required for the expansion are lagging behind requirements and the allotments as well as the appropriations are not being utilized effectively. At a recent Soviet Geological Conference it was emphasized that the present slow tempo of exploration of new oil lands is gravely endangering the plans for expansion. The disproportion between crude production and preparation of new oil lands is on the upgrade and any further spread is bound to lead to a calamity for which failure of the plans will be the least price.

Glavneft has heeded this serious warning and provisions have been made to revise the drilling plans for 1935. Prospecting is to be increased 40 percent over 1934 for which appropriations will be made available and steps have been taken to improve the technical supply for prospecting and exploration drilling.

Mr. Barinoff refers to lack of organization and laxity of discipline which have slowed down the results expected and have increased the cost of drilling. Exploration was carried on without any advance plans or without any approval of the geological survey. At the Baikal lake as well as at Chikishliar in the Turcoman republic extensive drilling of wells had to be abandoned owing to the fact that they were all sunk at unfavorable locations without previous geological consultation. Many wells were sunk in similar manner at Emba and Vostokneft and hence the present change of tactics.

A new problem which will come to the fore in 1935 is the problem of transportation and particularly at Emba. Koschagil which is a comparatively young oil field of the Emba group and produces about 7,500 bbl. of crude per day will get a gathering pipe line connection to the trunk line "Kaspiorsk" which is now under construction. An outlet will also be laid for the Iskin field of Emba which produces at present 2,500–3,000 bbl. of crude per day. The total crude production of Emba oil fields in 1934 amounted to 1,880,000 bbl. and the Soviets hope to further production of Emba in 1935 to 4,500,000–5,000,000 bbl. of crude. The Soviets assert that crude production of Emba has been restricted owing to lack of transport facilities.

Following exploration operations are scheduled for 1935.

Azerbaidzan (Baku region): Mishof-Dag, Zubeir, Sorincha-Gultba, Djemal Edin Duvani and Mashtag.
Grozni: South Vosnessensk, Alkhazovo, Psedak and Plievo.
Maikop: The Kutais district.
Sakhalin: The Katangli district.
Middleasia: Utch Kizil, Tugajevsk and Airitan.
Urals: Pokrovka, Shaligi and Kamarichinski.

Revised Plan for New Soviet Refining Construction

IN PREVIOUS issues of WORLD PETROLEUM we have discussed the problem of Soviet refining. As of today the Baku oil fields are steadily increasing crude production, while the refining facilities have remained practically stationary since 1931 at a total capacity of about 95,000,000 bbl. of crude per annum. The refineries include all old and new shell stills and all pipe stills for atmospheric and vacuum processing.

Crude production at Grozni has been on the decline since 1930 when the total refining capacities aggregated about 85,000,000 bbl. of crude per annum. At present Baku crude has to be shipped to Grozni in order to keep the plants on stream.

In 1931 the Communist Party decided to stabilize the refining capacities of the Caucasus and to enter upon a plan of new building along the Volga river (Gorki, Saratof, Yaroslavl) and at other strategic points in the interior near the consuming centers (Voronesh, Stalingrad, etc.).

The decline of crude production at Grozni necessitated shipment of crude from Baku and it is doubtful whether Baku will have sufficient surplus of crude available for the planned refineries on the Volga and inner regions. The refinery building at these points has been delayed since 1931 and it is likely that the plan will be shelved entirely or postponed for the time being. However, the steady industrialization of the country and mechanization of agriculture have increased the requirements of motor fuel and other petroleum products and in order to alleviate the disproportion between demand and supply the Soviets have now decided to expand the Baku refineries in the form of new building for a total of about 40,000,000 bbl. of crude per annum.

Plans were approved for the following new erections at Baku.

Five Pipe Still installations for an annual capacity of 40,000,000 bbl. of crude with corresponding vacuum lubeoil installations for 6,000,000 bbl. of topped crude.

Two compounded cracking units (topping, cracking and reforming) for 24,500,000 bbl. of gasoil with absorption-stabilization-rerun and treating plants.
One kerosene treating installation consisting of four divisions for a total of 30,000,000 bbl. per annum.
One lubeoil treating plant with three divisions for 3,500,000 bbl. of lubeoil.
One asphalt plant for 110,000 tons of asphalt per annum.
One coke installation consisting of 36 shell stills for 12,000 tons of coke.
One paraffin wax plant for 5,000 tons capacity.
One sulphuric acid plant for 40,000 tons of acid.

In view of the congestion at Baku, it was suggested that the new building be located outside of the city at some point on the Apsheron peninsula along the Caspian sea. This would have offered favorable shipping accommodations, but for various technical reasons and also lower cost of building, preference has been given to Baku. Congestion will be overcome by demolition of some 800 buildings together with a number of industrial enterprises including refineries.

A hugh sea terminal is under construction at present at the island of Artema. This terminal will free Baku from all shipments of light products such as kerosene, gasoil and Diesel oil. The total shipping facilities will aggregate 100,000,000 bbl. including Kala and Artema crude. A large part of Kala, Artema and Mardakhani crude will be shipped from the fields directly to Astrakhan for the inner regions and to Makhatch Kala for Grozni.

The new terminal will in some ways relieve Baku from congestion and make free space for new erections, but even so the new refineries will have to be distributed over several locations and then interconnected for unity of operation with the existing refineries. At "Chorni Gorod" ("Black Town") of Baku the present lubeoil treating plant, the paraffin wax plant and one 13-shell still battery will be razed in order to free some 30 hectares of ground for three atmospheric and vacuum pipe stills with a lubeoil treating plant and a coke and asphalt installation. At the Piatakof group of refineries the naphtha soap installation will be demolished in order to make space for the sulphuric acid installation. Between the Piatakof and Djaparidze refineries two 10 shell still batteries will be taken away and make space for the new paraffin wax plant.

Two more atmospheric and vacuum installations will be erected at "Beli Gorod" ("White City") of Baku, where the Stalin 12 shell still battery for lubeoil and the 10 shell still battery for motor oil will give way for new building. The two cracking units and the kerosene treating plant will also be erected at White City.

Production from New Refining Capacity at Baku

3,250,000 bbl. of straight run gasoline
1,000,000 bbl. of cracking gasoline
4,000,000 bbl. of ligroin
7,500,000 bbl. of kerosene
1,750,000 bbl. of Diesel oil
2,250,000 bbl. of lubeoil
14,000,000 bbl. of fuel oil
12,000 tons of coke
110,000 tons of asphalt

Cost of Refinery Construction

	Variant I	Variant II		
	Erections at Baku	Outside of Baku	at Baku	Total
Atm. Pipe Stills	20,000,000	23,000,000		23,000,000
Vacuum Pipe Stills	9,000,000	10,500,000		10,500,000
Cracking Units	14,200,000	17,500,000	1,700,000	19,200,000
Lubeoil Treating	9,000,000	7,500,000	3,000,000	10,500,000
Kerosene Treating	4,200,000	2,000,000	2,650,000	4,650,000
Gasoline Treating		1,500,000		1,500,000
Asphalt Plant	2,300,000	2,000,000		2,000,000
Coke Installation	3,800,000	4,500,000		4,500,000
Power Station	4,500,000	12,000,000		12,000,000
Repair Shop		300,000		300,000
Sulphur Acid Plant	7,000,000	4,500,000	3,500,000	8,000,000
Wax Plant	2,100,000		2,100,000	2,100,000
Total	76,100,000	85,300,000	12,950,000	98,250,000

Classified Cost Summary

Industrial Erections	76,100,000	66%	98,250,000	52%
Transport & Storage	28,900,000	25	65,250,000	34
Housing, etc.	10,000,000	9	29,000,000	14
Total	115,000,000	100	193,500,000	100

Of these quantities only some gasoline, lubeoil and Diesel fuel amounting to about 10 percent of the total will be shipped to Batum for export or in the northern direction by rail. The bulk of shipments will thus consist of sea transport for the interior markets and will require storage.

Storage Facilities to be Erected

2,300,000 bbl. Gasoline
3,000,000 bbl. Kerosene
750,000 bbl. Diesel oil
875,000 bbl. Lubeoil
5,600,000 bbl. Fuel oil

The new erections will also necessitate some pipeline reconstruction together with enlargements of the pumping facilities. New pipelines will be laid from the fields south of Baku such as Bibi Eibat, Lokbatan, Puta, Kergez and new pipeline extensions will be considered from the Stalin, Ordzonikidze and Kaganovitch groups of fields.

The cost of erections shown above consists of two alternatives. One for all erections at Baku and the other for erections outside of Baku in which case part of the erections would have to be made at Baku. All figures in Rbl. (One gold $ = 0.87 Rbl.)

J. WEGRIN

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Interview with Professor Sachanen

(Continued from page 253)

of salt domes are probably oil bearing, but their development will be a slow process faced with many hardships owing to the nature of a desert country devoid of communication and water.

The Ural oil fields are so far a negligible factor. Eight years of drilling at Perm where 60 wells were sunk have proven a complete failure. The Ishimbayevo oil field which has been under intensive drilling during the last four years has opened so far only 15 wells which produce between 15 and 2,500 bbl. of crude per day. Ishimbayevo crude, like all other Ural crude, is of high sulphur content averaging between two and five percent of sulphur.

In a general way it is very difficult to evaluate the future success or failure of the Soviet oil industry. Its objective possibilities cannot be overlooked; but the present state of prospecting and drilling and the slow tempo of development are bound to delay the expected progress. The sporadic and rather one sided development of production at the expense of Baku fields has also affected the refining end of the industry. The total daily output of Baku of 350,000 bbl. of crude cannot be run to stills at Baku where the daily refining capacity aggregates 287,000 bbl., while the Grozni refineries aggregating 231,000 bbl. of throughput per day cannot rely on Grozni crude and require Baku crude in order to keep on stream, throwing additional strain on the disorganized and ineffectively operating system of transportation.

Soviet refining, which has progressed considerably during the last few years, still lacks facilities for deep processing. At present Soviet crude yields about ¼ of the corresponding gasoline yield from crude in U. S. A. The larger proportion of Soviet crude consists of heavy grades which contain much less gasoline and owing to slow progress of cracking the total yield of gasoline from Soviet crude is generally limited. It does not exceed 12 percent from the potential (7 percent straight run and 5 percent cracking). Soviet cracking has been a slow process of development. Since 1927 only 30 units have been erected of which four units were put up during the last four years.

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A Correction

In the March issue on page 166 the name of the president of Commodity Exchange, Inc. was incorrectly spelled: the correct form is Jerome Lewine.

First Month of Petroleum Futures Market

Operation of the Crude Oil and Gasoline Futures Market in March. Gasoline Contracts Active—Strengthen at Month's End.

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AT THIS writing, the newly established petroleum futures market on the Commodity Exchange, Inc. in New York City is three weeks old. Unusual interest has been aroused in all quarters and speculators and oil men alike are closely following this innovation with an eye to its possible future growth and the place it may some day occupy in the marketing branch of the oil industry.

There is, naturally, much difference of opinion as to the eventual size of this market and to what degree the oil trade will avail itself of the facilities for hedging and marketing its products, but many competent observers feel that its eventual success is assured. It is generally agreed that six to eighteen months will be required before the breadth of the market and its open position have been more or less fully developed. Its growth will naturally be slow but a steady increase in activity is expected.

Considering the general dearth of activity in Wall Street coupled with the price weakness and uncertainty in commodity markets generally during March, this infant market got off to a very good start. Naturally, the gasoline futures attracted the most interest and 196 contracts of 42,000 U. S. gallons each (8,232,000 gallons) changed hands from March 5 to March 30 inclusive. Thirty-seven contracts of crude oil (37,000 barrels) went across the board during the same period.

With the exception of the first week or so, when prices for both crude oil and gasoline sagged slightly, the trend of the price level was upward and the end of the month brought more active strength, June gasoline closing at 6.06 cents per gallon (including one cent Federal Tax) 16 points higher than the opening and 26 points above the low. July crude ended March at $1.20½ per barrel.

Petroleum Trading During March

Month	Open	High	Low	Last
	Gasoline*			
June	5.82–.90 split	6.06	5.70	6.06
July	5.90	6.10	5.71	6.10
	Crude Oil			
July	1.20¼	1.20½	1.18	1.20½

*** Price of gasoline includes one cent Federal Tax.**

Contracts for June and July delivery selected as the most active months.

Strengthening of gasoline contract prices toward the end of March appears to be entirely warranted by the outlook for the spot market and the situation confronting the petroleum industry.

Reestablishment of the Federal Tender board in East Texas has practically eliminated interstate shipment of hot oil which in the past has been a perpetual threat to the crude oil structure and often the direct cause of gasoline price wars. Meanwhile, Texas has succeeded in curbing domestic shipments of hot oil through the organization set up while the Federal Tender board was ineffective as a result of the Supreme Court decision. The situation in regard to hot oil production seems to be definitely improving.

The outlook in Washington, suggests that restrictive legislation of a type to affect oil company earning power and effectiveness is unlikely although still a possibility as a result of the Blazer Committee's report suggesting separation of integrated companies. Efforts to balance supply and demand continue to occupy the attention of the administration as indicated by provisions of the administration's bill extending N.R.A. for two years. This provision gives the President power to regulate production, distribution and prices applying to natural resource industries such as oil, gas and coal.

Refinery gasoline prices advanced ¾ of a cent during March with the industry going into the season of heavy consumption in an excellent statistical position. The spot market for refinery gasoline was strong and active by the middle of March quoted at 3⅞–4 cents per gallon for 58–60 U. S. M. 62.9 and below octane rating; 63.0–70.9 octane was quoted at 4¾–5. Gulf Coast prices for export remained unchanged at 4¼ (2.51 cents gold).

Indications are that the excellent statistical position, maintenance of demand and control of production will push crude prices to $1.15 for 36 deg. Mid-Continent and gasoline prices to 5–5¼ cents for low octane grades in the Group 3 market by early summer.

Motor fuel demand which fell off seasonally during January as a result of severe weather continued strong in March.

For over half a century the cotton and wheat trades have been using futures markets very extensively for the purpose of hedging. Those interested in this development expect that the petroleum trade will do likewise. It is now possible, for example, for a refiner who has contracted with a marketer to deliver a million gallons of gasoline per month for the next twelve months at the posted price prevailing on date of delivery to hedge or protect himself against possible price declines in the future by selling for future delivery 24 contracts of each of the twelve ensuing monthly options. As each month goes by and he makes delivery of his actual gasoline to the marketer, he buys back or covers his short commitment in that month's option. Thus, if there is a decline in the price, the amount of money he loses on his sale of the spot gasoline is offset by the profit he makes on the technical short sale of the future contract on the Exchange.

In the above example it is also possible for the marketer, if he so desires, to hedge himself by purchasing futures for the coming months in which he has contracted to accept delivery and sell them out as each month passes, thereby protecting himself against possible price advance. The number of ways various divisions

THE

GASOLINE and CRUDE OIL
FUTURES MARKET
ON
COMMODITY EXCHANGE, Inc.

(Trading inaugurated on March 5th, 1935)

"The Gasoline and Crude Oil futures market on Commodity Exchange, Inc. is not designed to supplant the marketing facilities now obtaining in the industry, but is intended to provide the industry with a market where in it can obtain price insurance against adverse price movements. The industry has for years been disturbed by the disrupting effect of uncontrolled price fluctuations. There is no doubt that gasoline and crude oil futures market tends to impart a greater degree of stability to price movements as in the case of numerous other basic commodities where futures markets have been in existence for many years."

JEROME LEWINE of H. Hentz & Co.
President, Commodity Exchange, Inc.

"The inauguration of trading in gasoline and crude oil futures on Commodity Exchange, Inc. marks a new era in the petroleum industry. This industry is comparatively young and has prospered to an extraordinary degree, despite innumerable obstacles, because of the nobility of the commodity and the ability of the men in the industry. More problems have arisen in the past two years than at any other time in the history of this industry. New risks have been added and new devices for protection must be provided. It is just here that Commodity Exchange, Inc. finds its place in the picture, offering protection — insurance, if you like — against adverse price changes."

E. A. CANALIZO of Canalizo, Witkin & Co.
Chairman, Commodity Exchange, Inc., Committee on Petroleum

"The gasoline and crude oil futures market on the Commodity Exchange is an extremely interesting development. The Department of Commerce is very much interested in this development insofar as it may promote and further both domestic and foreign commerce. Anything that makes for stabilization of prices, which makes for a stable market and means the removal of barriers to business and to the flow of commerce — anything of this kind is very much of interest to the Department of Commerce and especially to the Bureau of Foreign and Domestic Commerce."

DR. WM. E. DUNN of The Bureau of Foreign & Domestic Commerce
U. S. Department of Commerce. (From an address delivered at the inauguration of trading in gasoline and crude oil futures.)

"To my way of thinking the oil industry should be quick to grasp the fact that the normal use of the exchange to an oil operator is to permit him to purchase or sell his oil or gasoline from and to the same concerns he has been used to doing business with for years. If the price at which he buys or sells is satisfactory to him, he then protects — hedges — it by executing offsetting sales or purchases on the futures market."

CHESTER NARAMORE, Petroleum Engineer, N. Y. C.

Units of trading are as follows:
GASOLINE—42,000 U. S. gallons
CRUDE OIL—2,000 Barrels of 42 U. S. gallons each

Price fluctuations are in multiples of one one-hundredth of one cent per gallon for GASOLINE and in multiples of one-quarter of one cent per barrel for CRUDE OIL.

Further information and details of the GASOLINE and CRUDE OIL Futures Contracts may be obtained at the Secretary's office

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of the oil trade may devise possible hedges is innumerable.

One of the problems, of course, in getting an adequate futures market under way in any trade is to develop a contract that is suitable in terms of size, delivery points, tenderable grades, differentials, etc. The Commodity Exchange, in determining its gasoline and crude oil contracts have arrived at specifications which they believe are the nearest possible to the needs of the great majority in the oil trade. It is natural that these contracts may not be suitable to all marketers, refiners, etc., but as the market grows and more people in the petroleum industry use it, suggestions for possible changes involving improvement will probably be made and the Exchange will undoubtedly give them utmost consideration.

Another of the problems involved in achieving success in the development of a futures market is to create a large interest both among the petroleum fraternity and speculators alike so that the purchase or sale of large quantities of the commodities at one time can be effected with a minimum change in price. This creation of an "open interest" is something that has to come slowly but as time goes on it will be possible to buy and sell larger and larger quantities of gasoline and crude oil futures with ready absorption by the market.

A third requisite for a successful futures market consists of adequate facilities for entering buying and selling orders and rapidly reporting back to the buyer or seller his price and the quotation of the market. This is adequately provided for by the efficient wire systems of the member firms with branch offices in leading cities throughout the world.

▼

SHIPPING

THERE are not wanting signs that an improvement is taking place in the world shipbuilding situation. This is particularly so in Great Britain, but here, no less than in other European countries, the improvement is attributable to some extent to the increasing number of tanker orders which have been placed. Within the last year, some 59 tankers have been ordered, with a total deadweight capacity of about 603,805 tons. These have been widely distributed throughout the shipyards of the world. As far as Holland is concerned, the whole of the shipbuilding industry is being held together by the orders which tanker owners, and in particular, the Anglo Saxon Petroleum Co. and the Standard Oil Co. of New Jersey have placed. Everywhere, interest is being shown in shipowning, as apart from the shipbuilding situation by virtue of the fact that an international conference seeks to establish an agreement as to rates and other matters which will make for the elimination of wasteful and ruinous competition. Furthermore, the British Government has at last moved and has granted the trampowners a certain subsidy which will assist them in fighting competition from other nations with similar assistance from their respective governments. In the opinion of many people, well informed on modern shipping thought, the assistance granted to foreign mercantile marines is more logical than that which is to be given to the British since it definitely assists companies to evolve types of ships which are superior to those which have gone before and from this point of view a subsidy is not merely an encouragement to inefficiency. The recent meeting in London of the International Tanker Owners' Association calls attention to the fact that one particular branch of the shipping industry has attempted, apart from any governmental aid, to work out its own salvation and the first accounts of the International Tanker Owners' Association revealed a surplus available for payment of laid up tonnage in respect of the first accounting period of not less than £355,778 of which £137,934 was absorbed in an interim distribution of 6/- per gross ton made in November last. The balance available, some £217,843, is being distributed in accordance with the decision of the council for the final payment of laid up allowance. The final payment was at least equal to the interim rate, thus making a total distribution of 12/- per ton per month for the last half year. The tanker pool, in spite of this fact, is not without its enemies, for it is considered that by a distribution of money to those ships which are laid up, it tends to keep in existence older vessels which can no longer, in the light of more modern developments, operate at a profit.

It is interesting to recall that the component parts of the tanker pool are not only the tramp tanker owners but also some of the big companies themselves. This, however, is a subject with which it is proposed to deal in a special Tanker Number of WORLD PETROLEUM.

The whole of the Anglo Saxon new programme has now been allocated to the shipyards in Great Britain, in Holland and in Denmark. These ships will be large ones of 12,100 tons, similar to that of the ANCYLUS type described in these columns recently, and also will include a group of smaller, 9,250 tonners, which are intended for working in special areas. The contracts have been especially welcome in Holland as suggested above. In addition, some Jersey Standard contracts for special ships have also been awarded, Germany in this case being particularly lucky, the whole of the vessels being built ostensibly for the German-American Petroleum Co., although one of the smaller ships, a steamer, will probably run in the Aruba trade or may be used, together with her sister ship building in Holland and officially constructing for the Netherlands Colonial Petroleum Co., on the Palambang service. It is reported that British shipbuilders were extremely disappointed in not obtaining any of the Standard New Jersey orders. Whether these were given to Germany for political reasons it is not possible at the moment to say, although there is every reason for supposing that this may partly be the case. However, one has been assured on very definite authority that questions of price and above all, of delivery, had a great deal to do with it. British builders are not, however, entirely without hope as far as Standard of New Jersey business is concerned, for at the present moment, enquiries are actively in hand with the majority of the principal British shipbuilders for a group of vessels for the Anglo-American Oil Co. of London. This company has not constructed for some four years, but in its last programme, built some very fine vessels.

Few orders have been placed for sulphuric acid carriers since the Anglo Saxon Co.'s AGNITA was completed in March 1931. This vessel was designed to carry not only sulphuric acid but also propane in vertical cylindrical tanks and was a relatively large ship with 4,959 tons deadweight. An interesting little ship, also for acid carrying has recently been completed in Amsterdam for the order of the Sulphuric Acid Carrying Co. Ltd. of that port, managed by G. P. Ketjen and Co. She is a single-deck ship with a forecastle and long poop, having a deadweight tonnage of 625 tons and a gross tonnage of 297.6. Her sea speed is about 9½ knots. She is intended for coastwise work and sulphuric acid is carried in 10 cylindrical tanks in the main hold of the ship, having a total capacity of 336 cubic metres, or about 590 tons of sulphuric acid. Special domes are placed in the middle of the tanks and are welded to the deck plating. These have piping arrangements on the main deck. There is a compressor in the forecastle which provides air for emptying the tanks. This at the same time can be used for driving the winch and hand windlass. Propulsion is provided by a Stork single-acting 2-cycle Diesel rated for about 390 b.h.p. at 215 r.p.m. This interesting and specialised little coaster is intended for local work in the North Sea and in the Baltic, for which she has ice stiffening forward.

A. C. HARDY

UNITED STATES

	Daily Crude Oil Production bbl.	Daily Runs to Stills bbl.	Total Motor Fuel Stocks bbl.	Imports for week bbl.	California Shipments East for week bbl.
Week ending March 2.....	2,491,500	2,475,000	65,277,000	1,272,000	389,000
	464,000*				
Week ending March 9.....	2,546,000	2,410,000	65,978,000	———	———
	459,000*				
Week ending March 16....	2,608,400	2,405,000	67,402,000	797,000	165,000
	443,350				
Week ending March 23....	2,600,100	2,384,000	68,284,000	1,202,000	327,000
	446,100				

Underlined figures indicate improvement in statistical position—decrease in production, runs to stills, gasoline stocks and imports.

*Estimated total production of the Rusk-Gregg field, East Texas, official and unreported.

Federal Control Developments

THE Federal Tender Board was re-established on March 2 in the East Texas field, under the authority of the recently passed Connally oil bill, as was reported in the preceding issue of WORLD PETROLEUM. The three members of the former board, dissolved by the decision of the United States Supreme Court which held Section 9 (c) of N.I.R.A. unconstitutional, were re-appointed; the board thus consisting of Norman L. Meyers, chairman, John F. Davis and M. S. McCorquodale. Regulations and forms required by the Federal Tender Board have been left practically unchanged from those used by the board before the Supreme Court decision. The administration of the Connally oil bill rests, as before, with Secretary Ickes, the Petroleum Administrator, but the prosecutions of violations under this bill have been assigned, by the executive order, to the Department of Justice. The re-establishment of the Federal Tender Board has in fact eliminated the interstate shipments of contraband oil from the East Texas field, while at the same time more effective state control has succeeded in greatly curtailing the intrastate shipments. The number of smaller refineries operating in the East Texas field, a standard measure of "hot" oil movements, has sharply declined from 35 to 40 before the re-establishment of the board to around 20 currently; while the "hot" oil production has been estimated to have declined to around 20,000 bbl. per day by the middle of March.

Several East Texas refiners, including Merriam Oil Company, Oil Sales Company and others, through their attorney, F. W. Fisher, already attempted, but so far unsuccessfully, to enjoin in courts the Federal Tender Board from operations. The complaints were based on interference of the board with shipments approved by the state authorities; on the desire of the complaining companies to restrain the board from examining their books and records; and on the alleged discrimination against the East Texas field, Federal Tender Board operating in that field alone. It was subsequently indicated that Secretary Ickes is planning the establishment of similar boards in Houston, Fort Worth and Oklahoma City, in part to avoid the complaints against discrimination, and in part the better to assist the two states in their proration efforts.

An interesting precedent was set on March 7 in the Longview district court when the jury convicted Harry Hunter, Kilgore refiner, of tapping a pipe line, sentencing him to two years in the state penitentiary. This case was the first tried under the new Texas law making such offense a felony. The defendant was charged with tapping a pipe line of the Gulf Production Company; H. Hunter denied his employes were authorized by him to tap the line, but his former construction foreman turned state's evidence, testifying the defendant was present when the alleged tapping was done.

N.I.R.A. Under Fire—Section 7a Out

WITH the National Industrial Recovery Act expiring June 16, 1935, the federal government and Congress have been preparing the way for its extension in an altered form, avoiding the apparent mistakes made in the original act. Early in March the Senate Finance Committee began a detailed study of the actual operations of the N.I.R.A., testimony being taken from Donald Richberg, executive director of the National Emergency Council. General Hugh Johnson is expected to testify later. In the meanwhile the necessity of extending the N.I.R.A. was seized upon as an opportunity by many political factions to criticize the act itself, the N.R.A. and its officers, and the present federal administration.

On February 27 section 7a (the collective-bargaining section) of the N.I.R.A. was held unconstitutional and void when applied to companies not engaged in interstate commerce. The decision was rendered by Judge John P. Nields in the Federal District Court of Delaware in the suit of Federal Government against the Weirton Steel Company of Weir-

Gulf Export Prices for Major Oil Products

	Product	Cents per Gallon			
		Feb. 21	Feb. 28	Mar. 8	Mar. 15
Gasoline:	U. S. Motor	4⅜	4⅜	4⅜	4⅜
	64/66–375 E. P.	4¾	4¾	4¾	4¾
	59 Oct. & below	4½	4⅝	4⅝	4⅝
	65 Oct. & above	4⅞	5	5	5
Aviation Gasoline:	73 Oct. & above	9	9	9	9
Kerosene:	44 w.w.	5	4⅝	4⅝	4⅝
	41–43 w.w.	4¾	4½	4½	4½
	41–43 p.w.	4⅝	4⅜	4⅜	4⅜
Gasoil:	26–30 transluse.	3	3	2⅞	2⅞
	30 plus transluse	3⅛	3⅛	3	3
Fuel Oil:	Bunker purposes (per bbl.)	$1.00	$1.00	$1.00	$1.00
Grade C:	Cargo lots (per bbl.)	$ .82½	$ .81	$ .80	$ .78
	Diesel oil (per bbl.)	$1.70	$1.70	$1.70	$1.70
Lubricating Oil:	Bright Stock No. 8	22½	22½	22½	22½
(New York Export	Bright Stock No. 6½	21½	21½	21½	21½
Market)	Warren E.	19	19	19	19
	600 Unfilt.	14½	14½	14½	14½
	650 Unfilt.	16½	16½	16½	16½
	600 Flash s.e.	17	17	17	17
	630 Flash s.r.	20	20	20	20
	Neutral 200 No. 3	35	35	35	35
	Neutral 150 No. 3½	28	28	28	28
So. Texas:	300 No. 3 pale	7	7	7	7
	500 3½ pale	7⅞	7⅞	7⅞	7⅞
	750 4 pale	9	9	9	9
	1200 4 pale	9½	9½	9½	9½
	500 No. 5–6 red	7⅞	7⅞	7⅞	7⅞
	750 5–6 red	9	9	9	9
	1200 5–6 red	9½	9½	9½	9½
Crude Oil:	East Texas crude delivered at Gulf port for Export	$1.18	$1.16	$1.17	$1.16

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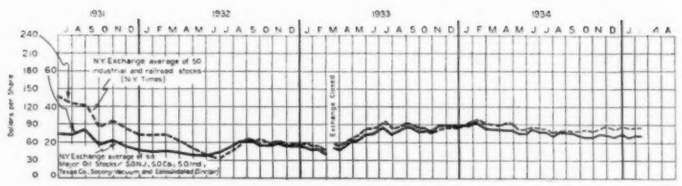
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Dollars per Share
N.Y. Exchange average of 50 industrial and railroad stocks (N.Y. Times)
N.Y. Exchange average of six Major Oil Stocks (Jersey, S.O.Ca., S.O.Ind., Texas Co., Socony-Vacuum, and Consolidated Oil Corp.)
Exchange Closed

Six major oil stocks in relation to 50 industrial stocks on the New York Stock Exchange.

ton, W. Va. Judge Nields also sustained as legal under N.I.R.A. the company union or employe representation plan of collective bargaining. The court ruled that "in its relations to its employes the company is not engaged in interstate commerce" and that the Weirton Steel Company's representation plan, the cost of which was paid by the employer, does not constitute "an act of interference, restraint or coercion," but "by a clear preponderance of evidence affords a lawful and effective organization of the employes for collective bargaining through representatives of their own choosing."

On the same date, February 27, Federal Judge Charles I. Dawson in Louisville, Kentucky, ruled that Congress lacks the power to regulate wages and prices in the bituminous coal mining industry, granting 35 mine operators in Western Kentucky a temporary injunction against the enforcement of the Bituminous Coal Code. Judge Dawson stated that "The citizens of this country have the right to conduct their business without unconstitutional interference or regulation by governmental authority."

On March 29 the administration attempted to clear up doubts concerning the extension of N.R.A. by introducing through Senator Pat Harrison (Dem. Miss.), chairman of the Senate Finance Committee, its own bill providing for a two-year extension of the N.R.A. Senator Harrison made it clear that this bill was submitted solely as a basis for discussion and subject to change in whole or in part. The bill was referred to the Senate Finance Committee as "a basis of discussion." It is understood that the purpose of the bill is to head off strikes and remove the uncertainty of business men among whom the impression was growing that Congress would let the N.R.A. lapse on its expiration on June 16.

Section 7a would be re-enacted as it is, in the administration bill. Promotion of monopolies by codes would be eliminated, as would all licensing provisions. Natural resource industries—oil, gas or coal—as well as public utilities and small industries would be subject to production, distribution and price control when deemed necessary by the President. Wage and hour regulation would be included and a number of small industries could be grouped under a general code. Labor's claim to equal representation with industry on the code boards is ignored in the administration bill.

Prices Trend Higher

THE re-establishment of the Federal Tender Board in the East Texas field, the more effective operation of the State of Texas "hot" oil restrictive measures and the approaching favorable motoring weather, contributed towards very considerable firming up of the refinery gasoline prices, the advance reaching ¾ of a cent during the past month; while the continued improvement in retail markets further stabilized the service station prices in areas previously ravaged by "price wars." Natural gasolines declined over one cent per gallon during the last month due to seasonally diminishing demand and because of increased production in East Texas and in California.

The more recent important changes in retail markets include: a reduction of from 2 to 3 cents per gallon in service station prices by the Socony-Vacuum on February 23 in parts of northern New York; an advance of 1.5 cents per gallon in tank wagon and 2.5 cents per gallon in service station prices by the Standard Oil Company of Louisiana on February 23 in New Orleans; an advance of 1 cent per gallon in service station prices by the Standard Oil Company of Nebraska on March 1 in its territory; and an advance of 1 cent per gallon in service station prices by the Standard Oil Company of Indiana on March 8 in Chicago area.

The crude oil prices during the past month remained very firm and unchanged at $1.00 per barrel for 36 gravity Mid-Continent grade, and at $1.00 flat per barrel for the East Texas crude.

Tank wagon/service station motor fuel prices per gallon, regular grade, including all taxes, in representative districts in the middle of March were:—11.75/14.5 cents in metropolitan New York (12.2/15.7 cents in Newark, N. J.); 12.5/16.0 cents in Boston, Mass.; 11.5/14.5 cents in Providence, R. I.; 14.3/16.3 cents in Chicago; 15.5/17.5 cents in Ohio; 16.5/18.5 and 15.5/17.5 cents in San Francisco and Los Angeles respectively; 16.0/18.0 cents in Oklahoma; 13.0/15.0 cents in Dallas and Fort Worth, and 14.0/16.0 cents in Houston, Texas; 13.9/15.9 cents in St. Louis and East St. Louis; and 24.0/27.0 cents in Montreal, Canada; all with a 2-cent differential for premium grades.

Refinery gasoline quotations in the Mid-Continent district advanced as much as ¾ of a cent a gallon during the last month and the markets continued strong and active at the middle of March. Major oil companies continued the support of the Mid-Continent prices making purchases in tank-car lots, offering on March 15 3¾ cents a gallon for low octane motor and 4¾ cents a gallon for middle grade gasoline. Refinery gasoline was quoted on March 15 in a very strong market at 3⅞–4

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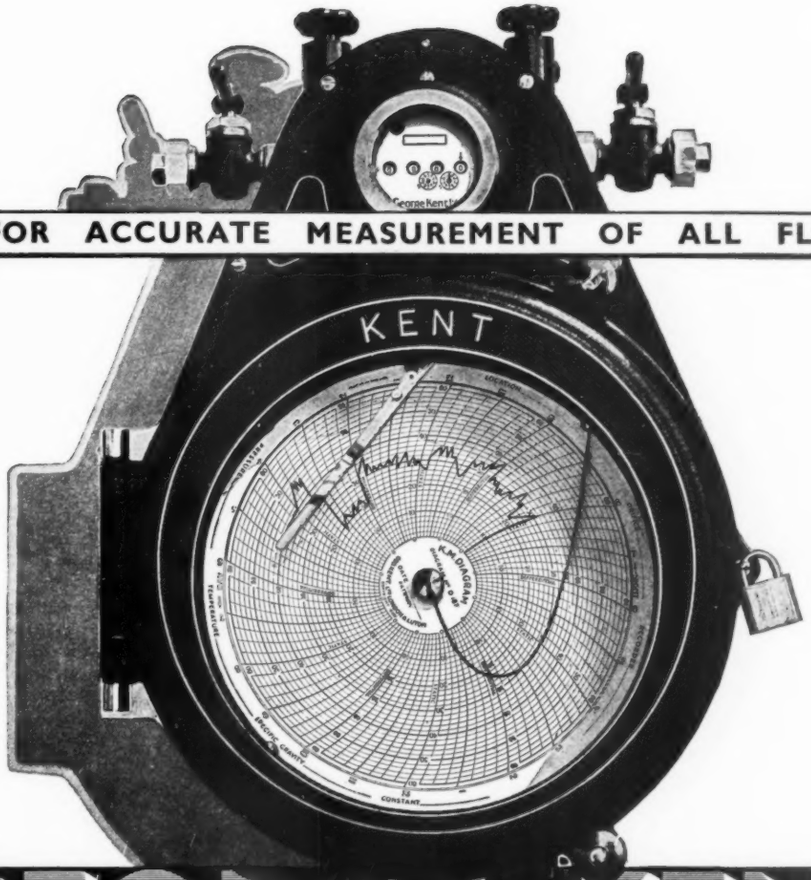

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Fig. 1

Cuts Larger, Stronger Core

Cores cut by all popular sizes of Globe Type K Coring Equipment are fifty percent larger than taken by old-style core barrels. The increased core diameter assures a greater percentage of core recovery due to the increased columnar strength of the core; minimizes the hazard of washing away cores taken in soft formations, and secures maximum drilling speed because the cutting blades remove less formation.

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Fig. 2

Globe Roller Bearing Rock Core Barrel

For obtaining cores in all hard formations, as well as where the formations are broken or consist of alternating strata, the Globe Type KR Roller Bearing Rock Core Bit (Fig. 2) provides a means that is positive and economical. A high percentage of recovery is assured by the use of two core catchers, one above the other. The lower catcher is of the dog type (Fig. 3) which secures an effective grip on cores from any formation, but is particularly designed to hold soft or broken material. The upper, slip type catcher (Fig. 4) is capable of pulling the hardest rock core.

Fig. 3

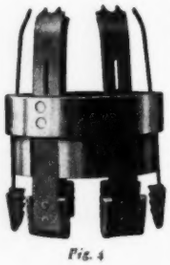

Fig. 4

The cutters are made of a special alloy steel, heat treated to secure the greatest wearing qualities. They are furnished with long, sharp teeth or short teeth for use in extremely hard formations, as desired.

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cents per gallon for 58–60 U.S.M. grade 62.9 and below octane rating in Group 3, Oklahoma market; 63.0–70.9 octane rating, U.S.M., was quoted at 4¾–5 cents per gallon; and 71 and above octane rating, U.S.M., was quoted at 5 cents per gallon. The East Texas markets were strong and its quotations were similar to Group 3 prices. On the East Coast, at Bayonne, U.S.M. grade 60.0–64.9 octane rating gasoline was quoted slightly lower at 5½–5¾ cents per gallon (3.32 cents gold*). Gulf Coast prices for export on March 15 were unchanged at 4¼ cents per gallon (2.51 cents gold*) for grade 58–60 U.S.M.

Natural gasolines showed marked seasonal declines, also influenced by large additions to stocks, quotations dropping in excess of 1 cent per gallon during the past month. On March 15 grade 26–70 was quoted at 2–2¼ cents per gallon (1.26 cents gold*) in Oklahoma and in North Texas; and at 2⅜ cents per gallon (1.40 cents gold*) in North Louisiana.

Kerosene prices continued fairly steady and on March 15 grade 41–43 w.w. was quoted at 3½–3¾ cents per gallon in Group 3, Oklahoma market; and at 5½ cents per gallon (3.25 cents gold*) on the East Coast at Bayonne. Gulf Coast prices for export declined as much as ⅜ of a cent per gallon to 4½–4⅝ cents per gallon (2.73 cents gold*) for 41–43 p.w. grade and 4⅝–4¾ cents per gallon (2.76 cents gold*) for 41–43 w.w. grade.

The trend of crude oil and motor fuel prices for the immediate future appears definitely upwards, influenced, as already indicated, by both field and seasonal developments; natural gasolines, however, should continue seasonally weak. Refinery gasoline at 5–5¼ cents per gallon for low octane grade, U.S.M., in Group 3 market; and $1.15–$1.25 per barrel for 36 gravity Mid-Continent crude oil appear as definite possibilities for early Summer.

Exports Continue Low

Beginning with January, 1935, the statistical and economic surveys of the United States Bureau of Mines began detailed classification of crude oil and refined products imports in bond for re-export, a classification previously published only by the Department of Commerce; this change in policy will go a long way towards eliminating much misunderstanding that existed till now in the independent oil circles, which assumed that all oil shipments entering United States were for domestic use and hence in direct competition with crude oil and its products produced in this country.

During January, 1935, total gross imports of all petroleum products into the United States amounted to 4,084,000 bbl., 131,700 bbl. per day, as compared with 4,874,000 bbl., 157,200 bbl. per day, imported during the preceding month; out of this total during

* U.S. Dollar at 41 percent discount.

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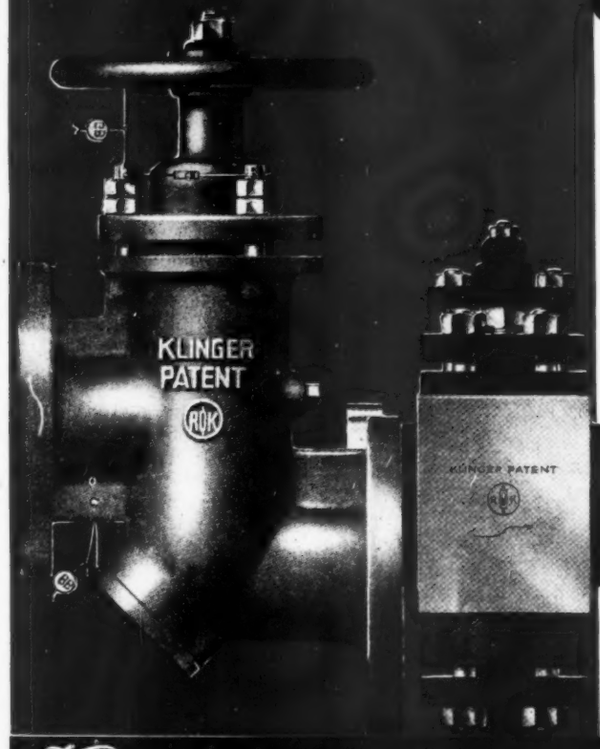

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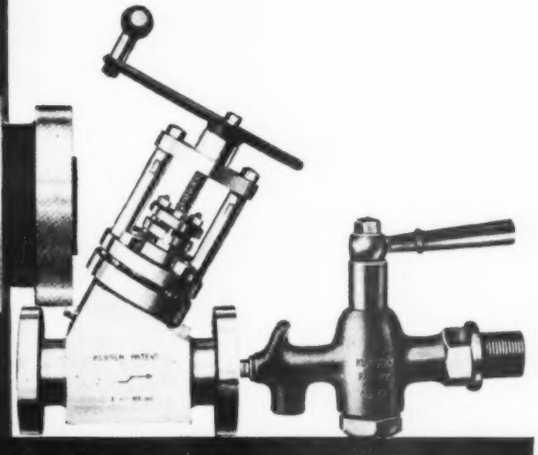

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January, 1935, 2,563,000 bbl., 82,600 bbl. per day, were imported for domestic use and 1,521,000 bbl., 49,100 bbl. per day, were imported in transit either for refining and re-export or for use in vessels in foreign trade. During the preceding month, December, 1934, 3,201,000 bbl., 103,200 bbl. per day, were imported for domestic use, and 1,673,000 bbl., 54,000 bbl. per day, were imported in bond as indicated above. The crude oil imported for refining and re-export amounted in January, 1935, to 549,000 bbl.; and in December, 1934, to 636,000 bbl. Therefore the net imports for January, 1935, and December, 1934, were well within the federal allowable of 108,400 bbl. per day.

Exports of all petroleum products, including motor fuel, during January, 1935, remained at a low level and unchanged from the preceding month, totaling 8,780,000 bbl., 283,000 bbl. per day, as compared with 8,630,000 bbl., 278,000 bbl. per day, shipped during December, 1934; they were, however, somewhat in excess of exports in January of 1934 when 7,569,000 bbl., 248,000 bbl. per day, were exported. Shipments of crude oil from United States during January, 1935, continued to be in small volume, amounting to 2,369,000 bbl., as compared with 2,432,000 bbl. exported during the preceding month, and 4,680,000 bbl. shipped in November of 1934. In January of 1935 crude oil exports constituted 27.0 percent of the total exports of all petroleum products, thus showing a definite reduction of crude oil exports from the United States in the past two months, possibly marking a permanent loss of markets in favor of the Iraq crude oil; this loss is accordingly indicated at some 70,000 bbl. per day at this writing.

Crude Production Curtailed

CRUDE oil and natural gasoline production during February, 1935, averaged about 2,670,000 bbl. per day, 20,000 bbl. per day above the preceding month; and 228,000 bbl. per day above the crude oil and natural gasoline production in February of 1934. The February, 1935, average daily crude oil production exceeded the federal allowable only by 34,300 bbl. per day, thus showing a further improvement in the statistical position of the industry. During February, 1935, Texas overproduced 677,000 bbl.; California overproduced 345,000 bbl.; while Oklahoma underproduced 510,000 bbl., 18,200 bbl. per day, thus further proving the increasing inability of the Oklahoma City field to make even its allowable. The first two weeks of March showed approximately similar relationship between oil producing states, with Oklahoma producing some 32,000 bbl. per day below its allowable; while Texas and California continued to exceed the quotas by about 25,000 bbl. and 20,000 bbl. per day respectively.

The crude oil runs to stills during February, 1935, averaged about 2,510,000 bbl. per day, or 76,000 bbl. per day above the runs to stills during the preceding month when 2,434,000 bbl. were refined.

Total stocks of all oils were increased during January, 1935, by 1,231,000 bbl., to a total of 565,379,000 bbl., indicating a daily gross addition to stocks of 39,700 bbl.; thus marking the first addition to stocks since August of 1934.

Motor Fuel Demand Lower

INDICATED domestic demand for motor fuel during January, 1935, averaged 905,000 bbl. per day, a seasonal decline of 7.94 percent under the daily average during December, 1934, when 983,000 bbl. were consumed per day; the domestic demand during January, 1935, was 44,000 bbl. per day below the domestic motor fuel consumption in January of 1934, a decline of 4.64 percent; 57,000 bbl. per day above the domestic motor fuel consumption in January of 1933, an increase of 6.68 percent; and 58,000 bbl. per day above the domestic motor fuel consumption in January of 1931, the peak year before 1934, an increase of 6.84 percent. The low domestic motor fuel consumption during January of 1935 can be probably attributed to unusually severe winter weather along the Atlantic Seaboard and in the Great Lakes region, and therefore that month's consumption is not a representative figure.

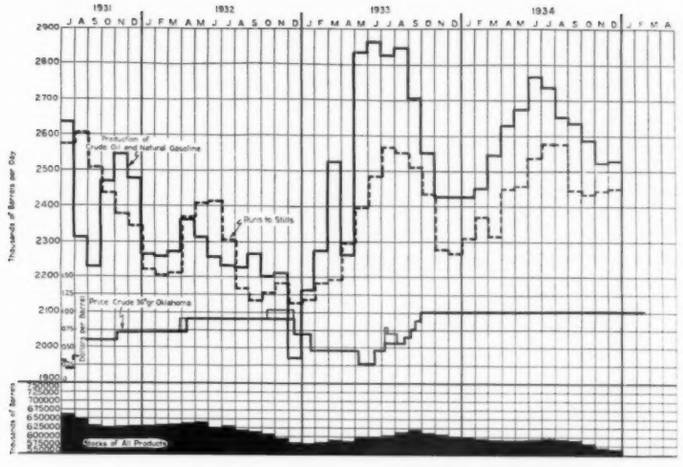
The NEW YORK TIMES weekly combined business index continued to fluctuate within very narrow limits during the past month, standing at 85.9 in the week ending March 9, 1935, as compared with 87.9 in the week ending February 9, 1935. The index stood at 82 on March 1, 1934; at 84.5 on March 1, 1933; and at 72 on March 1, 1932. As was the case during the preceding month all components of the business index maintained their respective gains. The general business situation in United States thus exhibited some hesitancy towards further increase in activity during the past month, apparently awaiting more definite indications of future Washington policies, which as yet are apparently undecided. The ever-increasing federal and state taxations in all possible phases of business and life continues to be the most unsurmountable obstacle to industrial and business recovery.

The daily rate of exports of motor fuel averaged 69,000 bbl. in January, 1935, 27.7 percent above the preceding month; 9.5 percent

Effect of Federal Proration Orders in Principal Oil Producing States

	Sept. 1933 to Feb. 1935 Cumulative Overproduction		Feb. 1935 Over-production	March 1935 Federal Daily Quota	Daily Average Production for week ending	
	bbl.	% of Total	bbl.	bbl.	March 2 bbl.	March 9 bbl.
Texas	35,111,000	56.2	677,000	1,020,000	1,049,000	1,045,000
Oklahoma	9,515,000	15.3	*	491,000	458,000	457,500
California	8,103,000	13.0	345,000	492,600	460,000	521,000
Kansas	2,190,000	3.5	110,000	139,700	146,500	143,500
United States	62,443,000	100.0	960,000	2,520,300	2,491,500	2,546,000

* Oklahoma underproduced 510,000 bbls. during February.



U. S. production, runs to stills and price of crude oil in relation to stocks of all petroleum products.

above the motor fuel exports in January of 1934; 14.8 percent below the exports in January of 1933; and 56.4 percent under the motor fuel exports in January of 1931.

On February 1, 1935, motor fuel stocks at refineries, plants, terminals, and in transit amounted to 57,796,000 bbl., a seasonal increase of 6,049,000 bbl. as compared with stocks on hand on January 1, 1935, indicating that during January motor fuel supply exceeded demand by 195,000 bbl. per day.

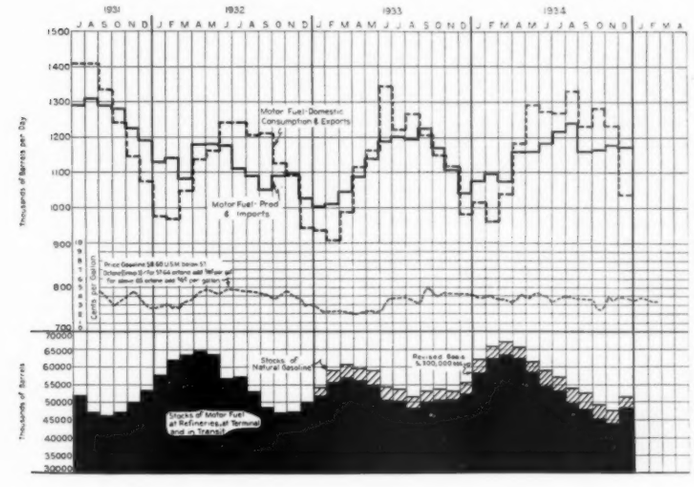
New Gasoline Pipeline

THE Champlin Refining Company of Enid, Oklahoma, announced early in March that it will begin immediately construction of a major gasoline pipeline extending from Enid, Oklahoma, where the company operates a large refinery, to Superior, Nebraska, a distance of about 250 miles. The projected pipeline will cross Kansas, touching Wichita and McPherson, thus suggesting that the Globe Oil Refining Company, with a 10,000-bbl. refinery and the Dickey Refining Company, with a 5,000-bbl. refinery, both in McPherson, and the Derby Oil Company, with an 8,000-bbl. refinery and the Barnsdall Refining Company, with a 5,000-bbl. refinery, both in Wichita, may eventually join the enterprise, in which case the line may be further extended to Sioux City, Iowa. The cost of the new line is estimated at about $2,000,000; it is to be of 6-inch seamless pipe, to be supplied by the Youngstown Sheet and Tube Company.

Field Developments

ON THE Gulf Coast in Chambers County, 50 miles due east from Houston and near Anahuac, the Humble Oil and Refining Company (S.O.N.J.) had a disappointment in its No. 1 Middleton in section 58, T.C.R.R. survey, when this wildcat, after showing very well on the drill-stem test, produced but 6 bbl. of oil per hour and subsequently developed water

U. S. consumption and exports, production, imports and prices of motor fuel in relation to motor fuel stocks.



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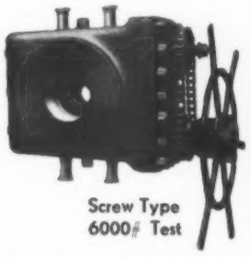

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Also on the Gulf Coast, in Galveston County, about 20 miles southeast from Houston and in the recently discovered Dickinson field, the Humble Oil and Refining Company No. 1 W. J. Jones in J. S. Sherman survey extended the field about 2,000 ft. due northwest for the best well in the field, flowing 960 bbl. of 37.5 gravity crude oil through ⅜-inch choke in 24 hours from the total depth of 8,039 ft. in the middle Oligocene. The Humble Oil and Refining Company controls most of the acreage in the Dickinson field, while the Pure Oil Company has the balance.

In the Cayuga field in the northeast Texas the Tide Water Oil Company made a location for a deep well to test the Trinity sand section. This location is of great importance, but inasmuch as Trinity sand tests proved to be failures within the last year on the Powell-Mexia trend the outcome of the proposed test is at best questionable.

A transaction of major importance is under acknowledged consideration of the Standard Oil Company of Indiana, which is currently checking over the properties of the Yount-Lee Company of Beaumont, Texas. The Yount-Lee Company owns some 700 producing oil wells with a current daily allowable production of about 20,000 bbl. per day in several fields of Texas and Louisiana gulf coast. The reported consideration is around $50,000,000. In case of consummation of this deal the Standard Oil Company of Indiana will probably enlarge the facilities of its Texas City refinery, which currently runs 30,000 to 35,000 bbl. per day of East Texas crude oil. This transaction, if completed, is a brilliant example of the desire of major oil refiners and marketers to protect themselves with large crude oil reserves, now threatened by unsuccessful search for new major pools.

Oklahoma

THE Fitts pool by the middle of March had 60 producing oil wells, each averaging 3,500 bbl. per day on potential tests, or a total daily potential of 210,000 bbl. Some 60 locations are being drilled at this writing. Inasmuch as the Fitts pool potential tests are made through small chokes, as compared with open flow test methods in Oklahoma City, it is quite apparent that true potential of Fitts is even now in excess of Oklahoma City's. The current allowable production of the Fitts pool is about 10,000 bbl. per day. The recently much publicized sharp drop in bottom-hole pressures in the Fitts pool is not alarming because the reservoir pressures tend always to decline sharply until a new pool is fully developed and subsurface pressures and conditions are stabilized. The salt water made its appearance on the southwest flank of the Fitts pool in two wells, but such encroachment is to be expected in a highly faulted field.

In Oklahoma City pool the current, as yet incomplete, potential open flow tests of the Wilcox sand zone wells show a decline of some 55 percent as compared with potential tests of six months ago. The new tests are based on 6-hour production tests, of which the last 4-hour production is multiplied by six to obtain the 24-hour potential. Final tabulation of current potential tests should be an excellent indication of the present status of the Oklahoma City field. The north end of Oklahoma City field was opened for further development by a vote of residents in the proposed extension after a prolonged fight.

Michigan

A 300 BBL. per hour producer brought in on March 28 in Montcalm County, Michigan, indicates the discovery of a new Michigan field. The wildcat was drilled by J. W. Leonard and gushed several hundred barrels of oil under high pressure before the well could be brought under control.

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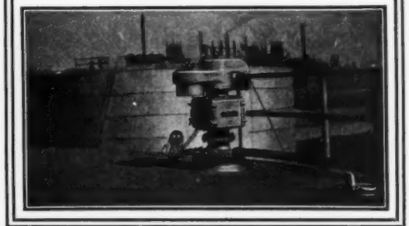

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